THE TELEGRAPHIC JOURNAL AND

# Electrical Review.

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## TECHNICAL TRAINING.

THE need for increased attention to the technical education of our young engineers and skilled workmen is questioned by no one; but the exact form in which that education should be administered is a subject which has given rise to much discussion and dispute. Last week we referred to a recent lecture by Prof. Ayrton, who described the nature of the instruction and practice imparted and pursued at the Central Institution at South Kensington, and pointed out wherein the objects of that institution differed from those of the Finsbury Technical College. The lecture was too elaborate for full treatment in the space at our command, and we therefore elected to limit ourselves to the consideration of the essential principle involved. There is, however, a very important practical side to the questions to which Prof. Ayrton gave attention, and upon this, whatever agreement there may be with regard to the main idea as to the necessity for the second and higher institution, there is likely to be considerable difference of opinion. Within the last few days we have had opportunities of discussing the subject of our last week's article with several gentlemen whose names are well-known in the electrical world, and have heard very decided opinions expressed as to the system of technical education pursued at the establishments of the City and Guilds of London Institute, some strongly denouncing, others as warmly supporting that system. Whilst some believed that improvement of the present arrangements should be sought by a closer imitation of the methods observed in some of the continental high schools—the High School of Vienna, for instance—others held that the practice of passing three, four, or five years in the schools, with no actual workshop experience, no contact with real mechanics, results only in the production of recruits for the vast army of the *dilettanti*. It may be that both views are considerably exaggerated, those of the supporters and those of the opponents of the present methods. It is not our intention, however, to enter into the discussion ourselves at this stage. We wish merely to give publicity to a suggestion which has been made by several of our friends to the effect that the opinions of those who are acquainted with the institutions, regarding the methods of instruction which are followed in them, should be invited. We shall be very pleased to ascertain the ideas entertained by our readers on the subject of technical education, with special reference to the teaching at Finsbury and South Kensington, but would suggest that correspondents should state their opinions in as brief a form as may be convenient, limiting their remarks to, say, one column of the ELECTRICAL REVIEW.

## SECONDARY BATTERIES.

THE last meeting of the shareholders of the Electrical Power Storage Company was, in one respect at least, remarkable, as showing the extent to which secondary batteries have been employed during the past year. It seems to be generally recognised, even by contemporaries whose *raison d'etre* is the championship of the gas interests, that there is an ample field for the company doing a considerable amount of paying business, although the *Gas World* thinks that success is almost altogether dependent upon the demand for electricity as a lighting agent. This may have been so up to the present and will probably so continue for a time, but assuredly in the not far distant future a demand will arise for a type of secondary battery constructed to meet the exigencies of tramcar work, and the question we would now ask is, can this want be supplied by any manufacturer now before the public? We have recently had several opportunities of inspecting a number of secondary batteries which have been employed in connection with tramcars and other developments of electric locomotion. In many instances the grids had, within a short period of time, become almost denuded of the paste; buckling of the most pronounced character had set in; and, in more than one instance, complete sets of cells were virtually rendered *hors de combat* in less than two months.

It would appear from our observations that however well plates formed of lead grids into which paste is pressed may answer for electric lighting, or for any other purpose in which they remain stationary, they cannot be considered in any great degree satisfactory for the purposes of electric locomotion, and we think it is time that manufacturers were made cognisant of this defect in the secondary battery.

We have already commented upon the system of construction adopted by Mr. Elieson, admirable from a mechanical point of view, but the electrical qualities of which do not yet appear to have been determined with any degree of certainty. We have also recently examined a battery in which the plates are formed in an exceedingly novel and original manner and which we cannot help thinking is destined to occupy, for whatever purpose used, a leading position both as regards first cost, capacity and durability, but we cannot point to a single instance in this country where secondary cells have as yet proved themselves to be a lasting form of motive power for moving vehicles.

Of the lithanode battery, upon which Mr. Kingsland writes so copiously in our other columns, we have no experience; but, so far as we are aware, it has not yet been tried for any kind of work involving disturbing influences such as are unavoidable in electric locomotion.

It would seem, therefore, that the attention of inventors might well be turned towards the mechanical improvement of the grids in the better known forms of secondary batteries, so as to ensure the contact of the paste with its leaden support for at least a reasonable time. M. Gadot has already accomplished something in this direction, but unfortunately his grid

must necessarily be formed in two halves, which is a disadvantage mechanically.

We cannot imagine any firm better able to take up and deal exhaustively with this question than the Electrical Power Storage Company, the representatives of which have already done so much towards perfecting the secondary battery for lighting purposes; and, if our remarks, which are based upon actual observation and not mere hearsay, will tend in any way towards bringing about a much desired improvement, our purpose will be fully served.

## THE ELECTRIC LIGHT AT THE NEWCASTLE EXHIBITION.

THE arrangements for lighting this exhibition are rapidly approaching completion, and the installations will possess several points of novelty. The work was from the first placed under the charge of a technical committee, the members of which have continued to superintend it personally; indeed, it is one of the special features of the Newcastle Exhibition, that the members of the Executive Committee have personally undertaken a very large proportion of the work connected with the building and the procuring and arranging of exhibits.

It was one of the original intentions of the Electric Lighting Committee to illustrate in the lighting of the building and grounds as many different systems as possible, and the work has been divided among five separate firms, of which two are essentially local. The main building is rectangular and surrounds a garden of about 2½ acres. It comprises a little more than 200,000 square feet of floor, and the courts are generally 30 feet high and 50 feet wide, and are flanked by T-falls 20 feet in width on each side. In the North Court there are three spans each 50 feet wide, the centre span being 35 feet in height, and the three spans with the T-falls give a total width of 190 feet. The engine room is situated about 100 feet from the N.W. corner of the building, and in consequence of this some of the electric light circuits are nearly half a mile in length.

Messrs. Clarke, Chapman, Parsons & Co., of Gateshead, will light by incandescent lamps of from 100 to 1,000 candle-power, the whole of the main courts, the largest area that has yet been illuminated solely by incandescent lights in any exhibition in this country. In this installation, besides the unwonted size of the lamps, the engines and dynamos employed will be of especial interest. Since the London Exhibition of 1885, at which this invention was first shown, this firm has been working at and improving its turbo-motors, and recently has been able to satisfy the Lighting Committee in a special series of experiments, that the amount of steam consumed by these machines is not greater per electrical horse-power than that required with ordinary high pressure engines and dynamos, while the engines occupy far less space than the latter. Practically these motors are turbines through which the steam passes, the apertures in the revolving discs being so adjusted as to allow for the expansion of the steam. The magnetic governor, by regulating automatically the supply of steam, ensures the constancy of the electromotive force of the circuit.

The high speed of these motors, 9,000 revolutions a minute, enables an armature to be employed of very slight resistance, so that not more than 1½ per cent. of the machine's out-put is absorbed by the armature and field-magnets. For the lubrication of the working parts, oil, heated by the steam and cooled by copper radiators attached to the pipes in which it flows, is kept in continuous circulation through the machine. Of the generators, which vary in out-put from 15 to 30 electrical horse-power, 14 are placed in the engine house near to the main building, and three in the Western Annexe to supply the current for the 800 candle-power lamps of that court. The large lamps in the North Court, as they are comparatively near to the engine room, are supplied with a current at 65 volts, but 100 volts will be the E.M.F. at more distant parts. The 100 candle-lamps in the T-falls at the side of the main courts, are arranged three in a series and so as to run at about 33 volts. There are in all 28 separate circuits for supplying the lamps, an arrangement which allows the E.M.F. in each circuit to be adjusted according to the requirements of the lamps and the distance from the engines. The burners of the lamps are bent rods varying in diameter from a little more than $\frac{1}{32}$ of an inch to $\frac{1}{18}$ of an inch, according to the power of the lamp. The conductors are all insulated, and, in addition, wherever branches are taken from the main cable, a safety fuse of tin wire is inserted, and this is done wherever a reduction of section of the conductor takes place. Between the flow and return of the main leads there is a distance of six inches, and of two inches in the branch leads. To provide against the accidental failure of any generator, about one-third of the number mentioned are spare ones and can be switched on to any circuit. The principal lamps, too, are arranged alternately on different circuits, so that the failure of any one machine cannot throw a court into darkness. In the model mine, which is also lighted by this firm, there are 55 lamps of 16 candle-power, and, in order that all may be in keeping, each will be provided with air-tight fitting, proof against fire damp, while the conductors will be cased in lead as a protection against damp or falling stones. Messrs. J. H. Holmes & Co., of Newcastle-upon-Tyne, light the picture gallery, dining rooms, and theatre, with incandescent lamps of 16 candle-power, and the current is supplied by seven "Castle" dynamos (two of them spare), each with an out-put of about 18 electrical horse-power. The E.M.F. at the terminals of the machines is about 128 volts, the distance between engines and lamps being so great that this is necessary in order to obtain 110 volts at the lamps without an excessive weight of cable.

The dynamos are driven by "Robey" engines, that which supplies the theatre current being provided with a Richardson's electric governor and Proell's valve gear in order to keep the E.M.F. constant, notwithstanding the great variations likely to take place in the amount of light required during the performances. On account of the great distance between the engine room and the theatre, which is very nearly a quarter of a mile, return leads are brought from the theatre to the electrical governor on the engine so as to keep the E.M.F. constant at the theatre itself. Other special arrangements have also been necessary in the theatre to give the stage manager complete control over the lights. All the lights in the auditorium can, by an arrangement of resistance coils and a system of switches, be reduced from 16 candles to about 1 candle whenever it is necessary to darken the theatre. The footlights and top lights upon the stage may also be reduced to either 5 or 1½ candle-power. As side lights there are six standards, each carrying seven lamps, and, instead of lime-light for projection effects, there are four arc lights of 1,200 candle-power, fitted, of course, in projection lanterns. No gas is admitted into the building, and all possibility of panic from accidental darkness is avoided by the use of three separate circuits with different boilers, engines, and dynamos. Three independent and simultaneous accidents must therefore occur before the theatre can be thrown into darkness for a longer period than that required to turn a switch.

In lighting the picture gallery very special precautions have been taken against risk from fire. The electroliers, on which 400 lamps are so fitted as to throw all their light on the pictures, are of wood, and are painted with silicate paint, and are practically fireproof. The thin wires, too, passing through the wood, are coated with asbestos. These wires, supplied by Messrs. Phillips Bros., of the Telegraph Works, Hackney Wick, were tested for the information of the

committee, and it was found possible to hold the wire in the hand while a current was sent through it which melted the copper, and to continue holding it until the copper had cooled down again. By such means, risk of fire is reduced to a minimum, especially as safety fuses are also introduced for each small group of lamps.

Messrs. Paris and Scott, of Norwich, supply the small lamps at the principal entrance, the central band stand, and the inner garden, as well as in the royal reception room and the offices. For these lights two dynamos made by the firm are used, either of which is sufficient for the whole work. As in the other cases, safety fuses have been inserted, but magnetic "cut-outs" are also employed, which break the circuit as soon as the current in their branch is increased by more than 25 per cent. of its normal amount.

The incandescent lamps used in the North Gardens and their buildings are provided by Messrs. Nicholson and Jennings, of Old Kent Road; they are all of 16 candle-power, and their current is supplied by two Victoria dynamos.

Messrs. Woodhouse and Rawson, Queen Victoria Street, E.C., furnish the arc lights in the gardens, and in the turrets over the main entrance. The current is supplied by two four-pole dynamos, and, as the lamps are arranged four in a series, the E.M.F. in each circuit is only 220 volts. In the main building the E.M.F. will never exceed about 125 volts, so that the risks both of fire and of bodily injury are exceedingly small. Besides enjoying these opportunities for a study of electricity as an illuminant, the visitor will also be able to see it employed for motive power. A tramcar, to carry forty-eight passengers, is to be driven round the gardens by a 20-horse motor. An electric motor will also be used to drive a set of tests on the engine plane near the coal mine, and thus show how such power may be utilised underground in place of steam.

A full account of the arrangements for the transmission of power and other applications of electricity in the exhibition will be given in a future issue.

## A NEW TYPE OF SECONDARY BATTERY.

By W. KINGSLAND.

THE paper recently read by Mr. Desmond G. Fitz-Gerald before the Society of Telegraph-Engineers and Electricians, on "Reversible lead batteries and their use for electric lighting," and the subsequent discussions brought to light much interesting matter in connection with the current ideas respecting these batteries, both as regards theory and practice, while a still greater interest attached to the new type of battery which Mr. FitzGerald then brought forward, and at which he has been working for several years.

The two types of secondary batteries—or as Mr. FitzGerald prefers to call them "*reversible*" batteries—with which we have hitherto been acquainted, are those of Planté and of Faure, and much ingenuity has been expended in various endeavours to modify the original forms of these batteries, both for the purpose of overcoming certain inherent defects, and also to obtain new patents.

The two types, however, have remained essentially unaltered. In the earliest or Planté type, we have the active material *formed* from the substance of the original plates of plain lead by a series of reversals. In the Faure type we have the active material applied in the form of a paste to the surface of the lead plate or support.

Mr. FitzGerald now brings forward a new type, in which one of the elements, viz., the anode or peroxide element, is composed wholly of active material, the use of metallic lead as a base or support or conductor being entirely abandoned. This idea is not a new one, many inventors having, I believe, worked in the same direction for some years back, and it would be difficult to say that the idea belongs to any one particular person. So far as I am aware, however, no really practical battery of this type has been brought forward previous to the "lithanode" battery of Mr. FitzGerald.

Now, a very little consideration will show that a plate composed wholly of peroxide of lead must have some advantages which it is impossible to obtain with a composite plate, while on the other hand the plate must be made of something very different from what is generally known as *active material*. It must be perfectly homogeneous, a good conductor, and possess considerable mechanical strength. If it be not homogeneous and also a good conductor, it will soon buckle and split by reason of the unequal effect of charge and discharge, whilst the density of the material must be very great, in the first place to give the requisite mechanical strength, and in the second place to prevent disintegration.

The two main advantages to be gained by the use of a solid plate are (*a*) an increase of capacity for a given weight and bulk, and (*b*) the absence of local action and the attendant sulphating. The latter of these will probably be reckoned the greatest gain, as it abolishes the greatest bugbear with which the users of secondary batteries have to contend, and what is indeed an inherent defect of the Planté and Faure types.

Looked at from a purely theoretical point of view, the new type would appear to be the nearest possible approach to perfection. I am not speaking now of Mr. FitzGerald's battery in particular, but simply of the *type*. Given a plate free from local action, sufficiently conductive to discharge evenly throughout the entire mass, practically indestructible under any conditions of charge or discharge, and having a capacity approximating to the electro-chemical equivalent of peroxide of lead, and it would be difficult to know in what direction to look for further improvement.

In what respects, then, does Mr. FitzGerald's battery comply with these conditions, and in what direction and to what extent is further progress possible? In the first place the "lithanode" plates are free from local action, and, secondly, the conductivity is very remarkable, though whether it is possible to advance further in this direction it is impossible to say. With regard to the indestructibility or life of the plates under varying conditions of actual use there is very little really practical evidence to go upon, although they have stood some severe tests, and appearances are all in their favour. It is when we come, however, to the question of capacity that we find the greatest discrepancy between the theoretical and the practical. Mr. FitzGerald tells us that careful analysis has shown that only 22·2 per cent. of the active material comes into use, or rather we should say, becomes reduced in the discharge. Under these circumstances it is rather a fallacy to speak of the plate as being made wholly of *active material*. We must, however, continue to use this term in contradistinction to the metallic conductor or support, and the interesting question arises whether it is *possible* to get a capacity at all approximating to the true theoretical value; whether, indeed, it is not necessary to have a *greater* bulk of active material for a given capacity with a solid plate than with one in which the peroxide is in comparatively close connection with a metallic conductor. This question is closely connected with the chemical theory of the battery. According to Mr. FitzGerald the actual amount of peroxide reduced corresponds very closely with the theoretical amount calculated from the capacity obtained, and what remains in the plate is unaltered peroxide. Notwithstanding, however, the presence of this unaltered peroxide in considerable bulk, the E.M.F. of the cell is no longer 2 volts. Theory would point to the conclusion that so long as any peroxide remained, the E.M.F. *on open circuit* would still be 2 volts. Such, however, is not the case. A large amount of the active material is inert, and the question is whether there will not be more rather than less of this in a solid plate than in one consisting of peroxide in contact with a metallic conductor; whether, in fact, any material can be invented which will not give a

better result when used in connection with a considerable surface of conductor, and that thus it is not all gain, so far as capacity for weight is concerned, to discard the use of a grid or other form of support.

We should expect if this were the case to obtain the greatest capacity per lb. of active material in a battery of the Planté type, a less capacity in the Faure type, and still less in the solid plate. I do not know of any data respecting the capacity per lb. of active material in a battery of the Planté type, and indeed this would be very difficult to estimate; but it will probably be conceded that it must be much greater than that of the "pasted" cells. With respect to these latter, some figures were supplied by Mr. Sellon during the discussion which followed Mr. FitzGerald's paper, and it would appear that in the E. P. S. cells the weight of the active material deducted from the weight of the grid would give an average capacity of about 30 ampère hours per lb. Mr. Reckenzaun in some figures recently published in the ELECTRICAL REVIEW gives the capacity at an average of about 25 ampère hours per lb. It was pointed out by Mr. Drake that this includes the capacity which would be obtained from the grid alone if the active material were removed, and this he estimated at one-quarter the total capacity. This is probably somewhat high, but even deducting this we have a better value for the E. P. S. plates than for the "lithanode." The difference, however, is not striking, and indeed is much smaller than would be expected when we consider the way in which the peroxide is subdivided by the grid, and the enormous surface of actual contact, compared with the very small contact surface of the platinum used with the "lithanode" plate.

These figures may be varied within somewhat wide limits by varying the rate of discharge, and although pointing to the conclusion that the active material is used to better advantage in the grid, it still leaves the question open as to whether a solid plate may not actually be made which possesses such properties that it can be used to as much advantage in a solid form, as in a grid. This could of course be determined for the "lithanode" by actual experiment, and the fact that both the rate of discharge and the capacity is improved by using a large surface of platinum contact is pretty conclusive in this direction. It is probable that if a grid were "pasted" with "lithanode," the capacity would be much better than what is now obtained from the material used in the E.P.S. cells. The capacity which may be obtained from different mixtures varies very much, although they may all have been converted by electrolytic action into what on analysis would be found to be peroxide of lead. The difference is a physical one and not a chemical one, but is dependent upon conditions which it is difficult to ascertain. Density, conductivity, and permeability appear to be the principal factors in the matter, and the best results are obtained by a happy combination of these. It might be thought that the more dense material would be less permeable, and would therefore give less satisfactory results. This, however, is not the case. "Lithanode" is extremely dense, yet gives better results than some of the more porous material which has been tried. Is it possible then to make a solid plate so permeable that the acid shall have access to every portion of it so as to become *active* throughout the entire mass, while at the same time the plate shall retain its conductivity even to the last portion of the discharge? It is in this direction that Mr. FitzGerald appears to think we may legitimately look for further progress, but on the evidence before us, I think we must discard the idea that any active material can be used to better effect so far as capacity for weight is concerned, in the form of a solid plate rather than in contact with a large surface of metallic conductor.

What takes place in the active material during the discharge of the cell? Whether it be the formation of sulphate or of oxide or of sesquioxide, the physical result is the choking up of the substance so as to render a large portion of it inert; so much so that there is a permanent diminution of the E.M.F.; and if the change is such as to affect the E.M.F. on open circuit, where it is not a question of resistance, it is difficult to conceive how a near approach to the theoretical capacity can be obtained along with sufficient conductivity to keep the current constant. There must, in fact, always remain a large proportion of unaltered material in the plate, not merely on account of this choking action, but also to supply the place of a metallic conductor.

Notwithstanding this there may be a considerable gain in the *total* weight of the plate in favour of the solid form. When a lead grid is used, it must be of considerable weight in order to give it the necessary durability, and in doing away altogether with this dead weight, the loss of capacity is more than compensated for. Mr. Sellon states that in a plate weighing 5 lbs., the actual weight of active material is 25 oz., leaving 3 lbs. 7 oz. as the weight of the grid. The capacity of this plate is 47 ampère hours, which is equal to, say, 9·5 ampère hours per lb. of plate, as against 16 obtained with the "lithanode." This is a considerable gain, and one quite worth having in the case of portable batteries.

The question of weight, however, is not the most important one. The prime cost, the efficiency, and the durability of the battery will mainly determine its usefulness. With regard to these, however, we are as yet without any data by which to compare the "lithanode" battery with other well-known forms now in the market, and we must wait for the price list and the result of practical operations, before we can do so. That the first cost will be somewhat high appears likely, but it is probable that the efficiency will be very great, that there will be less waste of energy in charging, and that the absence of local action and the apparently indestructible character of the plates will greatly reduce the cost of maintenance.

We must now consider somewhat more fully the advantages to be gained in this direction. The question of the action which goes on between a lead plate and the peroxide with which it is coated has given rise to much controversy. It is stated thus by Messrs. Gladstone and Tribe:—"In a Planté or Faure battery the mass of peroxide which is in contact with the metallic lead plate expends its energy slowly. How comes it to pass that if the same mass of peroxide be brought into connection through the first lead plate with another lead plate at a distance, it expends its energy through the greater length of sulphuric acid in a tenth or a hundredth part of the time?" The answer given, and the theory which appears to be generally accepted, is that the local action which takes place at first, results in the formation of sulphate, which interposes between the active material and the lead plate a resistance, which is a bar to further action. Mr. FitzGerald, however, in his paper, attacks this view, and maintains that a good contact between the peroxide and the lead is necessary, at least at one point, otherwise the main current would be as much impeded as the local one; and, carrying this view still further, he argues that since the local circuit must be from the lead to the peroxide through the electrolyte, and from the peroxide back to the lead by simple conductive contact, the more these points of conductive contact are increased the greater will become the electrolytic resistance; so that finally we arrive at the best state of things by ousting the electrolyte altogether, and having between the lead and the peroxide a perfect unbroken contact. Now, theoretically, this may be a very desirable state of things, but it can hardly represent what occurs in actual practice, and, moreover, it does not afford any new light on the problem. There is, however, another explanation which appears to have been overlooked. In attributing the slowness of the local action to the formation of sulphate "clogging up the interstics of the peroxide," and in the question as stated by Messrs. Gladstone and Tribe, it appears to be taken for granted—if not expressly so stated—that unless the peroxide were in some way protected from the lead by something of the nature of a resistance, the whole of the energy of the peroxide would expend itself rapidly, as it does when "brought into connection through the first lead

plate with another lead plate at a distance." In the case of local action, however, just as much as in the proper discharge of the cell, there must be a positive element taking its legitimate share in the operation; the positive element of the local couple being, of course, the lead support; a *metallic* lead plate. The positive element of the battery, however—the "lead plate at a distance"—, is a *spongy* lead plate; a very different positive from that of the local couple, and the peroxide does *not* expend its energy rapidly when a *metallic* lead plate is made the positive element of the battery, any more than it does when such a plate is in actual contact with it. We need not therefore form any theories as to the number of points at which the peroxide is in actual contact with its lead support, or as to the clogging action of the sulphate in the interstices; it is the badness of the positive, and not action on the negative of the local couple, which forms a bar to local action.

An accumulation of sulphate may occur by reason of what has already been formed being imperfectly acted upon during the charging process, and it is also to be noticed that this *visible* sulphate forms principally from the comparatively loose peroxide *formed* on the lead plate itself, and not from the denser active material. If a strip of lead be used as a contact with a solid plate of peroxide, there is quickly an appearance of sulphate, but this does not make its appearance if the lead strip be used for the discharge only, the charging contact being a strip of platinum.

In making experiments in this direction I have noticed a somewhat curious phenomenon. When a piece of solid peroxide is placed in contact with a strip of plain lead, and immersed in acid and water, one would naturally expect that a certain amount of local action would take place, and according to the generally accepted theory, sulphate of lead would be formed, which would prevent this action from extending very rapidly. I have found, however, that *generally* the solid peroxide will actually peroxidise its own lead support, which is then capable of giving two volts with a spongy lead cathode, when the solid peroxide is removed. This was first noticed with a piece of solid peroxide which had been much overcharged, and which was taken out of the electrolyte streaming with gas, and immediately applied to the lead. I have since found, however, that the same thing occurs with pieces of peroxide which have been lying by in a dry state for several months.

With a battery of the new type it is, of course, impossible for any local action to take place between the peroxide and the platinum contact, and such a battery may be allowed to stand for an indefinite time, either fully or partially charged, without any attention being given to it. Neither is it necesary to give it a close and constant attention when in use, or to watch each individual plate for the first signs of an incipient fault. The gain in this respect is probably much more important than would at first sight appear. We have been told that the secondary battery in its best known form is as near perfection as it is possible to bring it, and that any further advantage to be gained must be in the direction of better management and improved methods of working. This may be true of the particular type, but a battery which requires no *management*, which is able to take care of itself, must be looked upon as a very decided advance.

In what respects the "lithanode" battery will prove itself a worthy pioneer of the type, we shall no doubt soon have the opportunity of judging by the test of practical experience.

## CONSTANT CURRENT MOTORS.

IN your issue of the 8th instant you criticise with some severity the weight of the Hochhausen motor as compared with its power, mentioning that there are at work in this country motors which, for the same power, weigh some 50 per cent. less. Apart from any considerations respecting the particular motor referred to, it must not be forgotten that motors which work with constant current must necessarily be heavier than those working with constant potential; and any comparison as regards mere weight between the two types must therefore in the nature of things lead to an unfair judgment. The shunt motor which, without any special arrangement for regulation, works satisfactorily on a circuit of constant potential, is of course unsuited for constant current working, and up to the present time no constant current motor with a purely electrical governing device has been successful. Of suggestions for such motors where the regulating devices have consisted in some peculiarity of the winding we have had enough, but their success has yet to be demonstrated. Hitherto some mechanical appliance, depending for its action on the variation of speed or variation of load, has been invariably employed.

In the motor of Hochhausen, the current in the armature is constant and independent of the load, whereas the strength of field varies greatly, due to the magnet coils being cut out altogether when the load is removed, and producing their maximum field when the load is a maximum. When unloaded the field is due to residual magnetism only, when fully loaded it is such as to induce a difference of potential of 200 volts in the armature. The cause of the increased weight lies in the necessity for this great variation of field, since the armature must have very few convolutions and contain a large amount of iron if sparking is to be avoided. These remarks may be pointed by a practical example. In the Phœnix arc machine described in the REVIEW for March 18th there were wound on the armature convolutions sufficient to produce 700 volts, the ratio of their number to the cross section of the core being smaller than is usually the practice. When the machine was tested under the condition of constant current in the armature to obtain the curve, B, sparking commenced under 400 volts, and a readjustment of the brushes was necessary. But only to a certain point could the sparking be cured in this way, and under 200 volts readjustment was found ineffectual for its prevention. To make the machine capable of working without sparking at any difference of potential from 0 to the maximum half the convolutions had to be taken off the armature; the maximum output was in consequence halved, and the ratio of weight to output doubled.

Here, then, is the price paid for a generator capable of working with constant current, but in a motor the conditions are even more unfavourable. In a generator the field coils are never entirely cut out, for the E.M.F., when the machine is short circuited, must be such as to send the current through the armature and the part of the magnet coils left in circuit. The field required is in consequence considerable, although the difference of potential at the terminals may be *nil*. In a machine giving 300 volts as its maximum it might be necessary to create 20 volts for the E.M.F. absorbed internally when short circuited at the terminals. The field in this case would always have at least one-sixteenth of its maximum strength, but in a motor it is not so. When unloaded, the field is only strong enough to make the armature spin round, overcoming its own friction, and it would appear from the description of Hochhausen's motor that the residual magnetism is sufficient to furnish this strength. It is questionable whether the armature turns can be made so few as to avoid sparking in a constant current motor when thus unloaded, but even if a certain amount of sparking is permitted, the field due to the current through the armature must be small as compared with that supplied by the magnets at their weakest. It is thus demonstrated that in motors designed for working with a constant current the ratio of power to weight must be small.

W. B. E.

**Electrical Fishes.**—Prof. J. S. Burdon Sanderson, M.D., LL.D., F.R.S., will read a paper at the Royal Institution on Friday, May 13th, on "Some Electrical Fishes."

## ELECTRICAL DISTRIBUTION BY ALTERNATING CURRENTS AND TRANSFORMERS.

By RANKIN KENNEDY.

(*Continued from page* 321.)

TRANSFORMERS—(*Continued.*)

A VERY simple and most convenient form of transformer employed by me in some experiments in 1885 consists of a laminated Siemens shuttle-wound armature, S, in fig. 15 half size. On this was wound 40 turns of No. 12 wire as a secondary, *c*, *d*, and over this 800 turns No. 24 silk covered wire as a primary, *a*, *b*, the length of the armature being about 6 inches. This form gives very good results for self-regulation and economy, and I use it generally for distribution purposes for small installations, say up to one or one and-a-half horse-power.

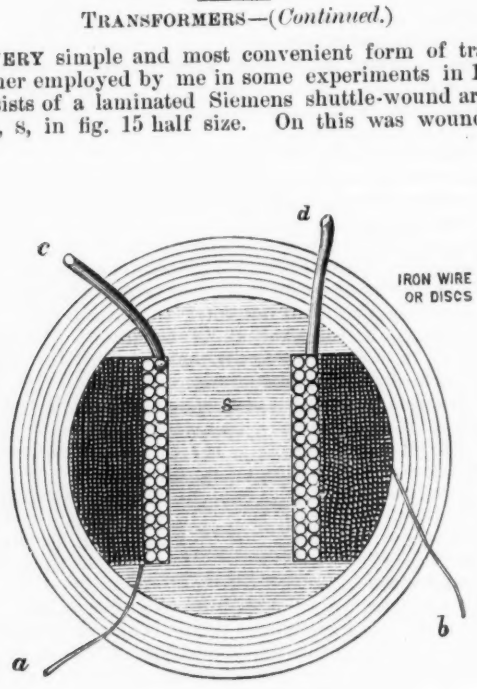


FIG. 15.

The outer sheathing may be of iron wire or of iron discs, and should be made so that the armature may be withdrawn for repairs.

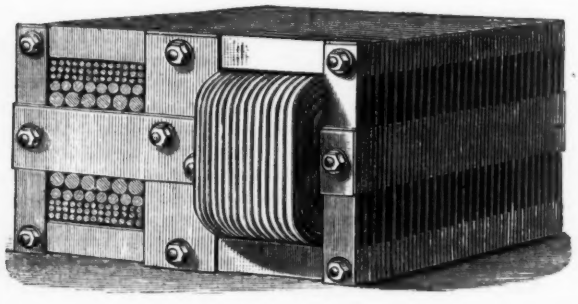

FIG. 16.

Fig. 16 shows the construction of the large transformers employed by me to raise the pressure of the electric energy at the generating station; it is built up entirely of hoop iron and bound together by bolts as shown. The primary coils and the secondary coils are wound on a mould and then slipped on; the thick wire, which is in this case the primary, being first put on, and the secondary or fine wire slipped over it; finally, the strips of iron are placed on the ends and this closes the magnetic circuit. The lamination and ventilation in this form are very perfect.

The Ferranti transformers, fig. 17, end view, and fig. 18, side elevation partly in section, are also built entirely of hoop iron. The hoops are laid out in four bundles, C, C, C, C, fig. 17, straight and close together; the thick secondary wire, D, D, fig. 18, is wound on over the middle portion of the bundles of hoop iron, and over this thick wire the fine primary wire is slipped in sections which have been previously wound on a mould. The hoop iron bundles are then divided at X, X, fig. 18 into halves, one half bending up over the top and the other bending down under the bottom, thus closing the magnetic circuit; finally, the whole is enclosed in a cast iron shell, A, A. The lamination in this construction is hardly perfect as the flat side of the iron is presented to the penetration of the lines of force, but altogether it is a very practicable construction.

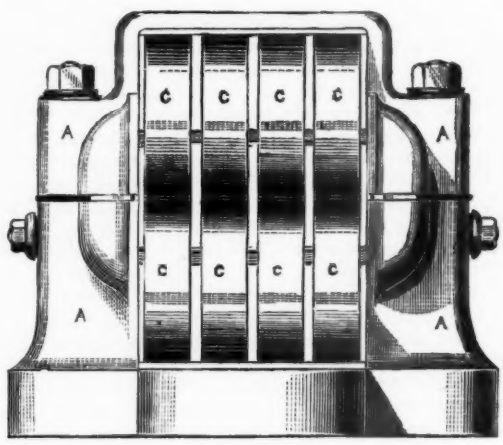


FIG. 17.

There are many other forms of transformers, but as they are all similar in principle and are merely simple modifications of the leading types herein described, they are not of sufficient interest to occupy space here.

In America the parallel system and the closed magnetic circuit transformer have been introduced by the Sun Electric Company, of Woburn, Mass., under the name of "Mr. Slattery's system," and also by the Westinghouse Company, of Pittsburgh.

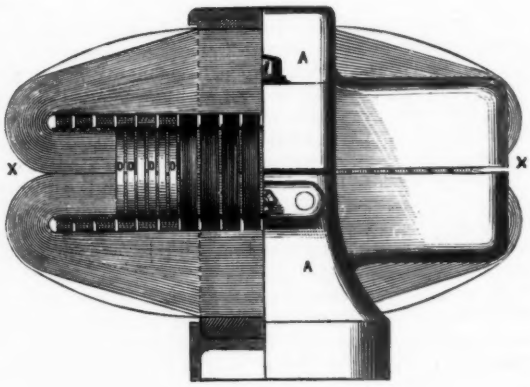


FIG. 18.

Slattery's system embraces a simple ring converter the same as my 1883 converter.

The Westinghouse Company have obtained the patent

of Gaulard and Gibbs in America, the claims in which I give here complete.

1. The hereinbefore-described art or method of electrical distribution and conversion, which consists in establishing in a closed electric circuit, a current of alternate and equal positive and negative potential, producing by the influence of such current an inductive field of alternate polarity, and thereby inducing in translating devices situated in an independent closed circuit traversing such field, a similar alternating secondary current of greater quantity and less potential than the originating or producing current.

2. In a system of electrical distribution, an inductorium or converter, in which the length of that portion of the conductor traversed by the primary current within the magnetic field created by itself, exceeds the length within the same field of the conductor traversed by the secondary current, in combination with a dynamo-electric generator producing alternating electric currents or pulsations of equal potential and duration, and translating devices actuated by said secondary current.

3. In a system of electrical distribution, an inductorium or converter, in which the resistance of that portion of the conductor traversed by the primary current within the magnetic field created by itself, exceeds the resistance of that portion of the conductor traversed by the secondary current which lies within said field, in combination with a dynamo-electric generator producing alternating currents or pulsations of equal potential and duration, and translating devices actuated by said secondary current.

4. In a system of electrical distribution, a dynamo-electric machine, organised for the production of alternate positive and negative currents, equal to each other in potential and duration, in combination with the primary circuit of an inductorium or converter organised to induce in its secondary circuit alternating currents of lower potential and greater quantity than those of the primary circuit, and one or more translating devices actuated by said secondary currents.

5. In a system of electrical distribution, the combination of an inductorium or converter, having its primary and secondary circuits constantly closed, a dynamo-electric generator for producing alternating currents of equal potential and duration included in said closed primary circuit, and one or more translating devices included in said closed secondary circuit, substantially as set forth

These claims construed into simple language mean simply that Gaulard and Gibbs claim to be the only true inventors of the parallel system of working potential transformers at constant E.M.F. in the mains. The patent is dated October, 1886.

Judging from recent utterances in America, where the introduction of this system has created a somewhat amusing flutter among the electrical fraternity, the distinctions existing between the two systems, series and parallel, are not yet recognised, for the simple reason that the parallel system with the potential transformer has been bodily imported by them from Britain in a complete and perfect form. The series system has never been tried in America and therefore they have had none of the failures attending attempts to work that system. The parallel system has been a great success, but it was just as great a success in Europe two years ago.

I shall now take up the consideration of the actions in the transformer. From a magnetic point of view they are exceedingly interesting, in fact, the consideration of the magnetic effects and actions give us an entirely new and wider view of magnetism than can be obtained from the consideration of any other electromagnetic instrument or machine. We shall also take note of the rapidly increasing practical applications of the transformer to purposes other than the distribution of electric lighting.

(*To be continued.*)

**A New Theatre.**—Mr. Edward Terry is building a new theatre in the Savoy, and no doubt he wishes his house to present as finished and elegant an appearance as is possible. To attain this end we would recommend the adoption of electrical illumination, which will not only be effective both for lighting and decorative purposes, but will promote economy by avoiding the necessity for frequent redecoration of the interior. Mr. Walter Emden, 36, Southampton Street, Strand, W.C., is the architect, and those of our readers on the look-out for business might do worse than communicate with that gentleman.

## PRACTICAL NOTES CONCERNING THE CONSTRUCTION, USE AND MANAGEMENT OF STORAGE BATTERIES.

By A. RECKENZAUN.

(*Continued from page* 320.)

*Secondary Batteries as Regulators.*—We have already stated that the resistance of the generator has a great influence upon the steadiness of the light when the speed of the prime mover is somewhat irregular. There is, or has been an impression among engineers, that an accumulator, however small, would suffice for the purpose of regulating the flow of current from a dynamo of any dimensions. This would only be true if the E.M.F. of the cells were constant with varying rates of discharge. But we know that the *rate* of discharge must be proportioned to the *capacity* of the accumulator, and this capacity, we have explained, depends upon the active surface of the plates. The internal resistance of the cells has in a measure some influence upon the regularity of the discharge, but the supply depends mainly upon the rapidity with which the chemical action may take place upon the plates. The volume of active material, as well as its distribution within the cells, determine the rate at which the current can be furnished; therefore, in order that an accumulator may furnish the maximum current that may be demanded from it in an electric light installation, its *capacity* must be large enough to allow the action to be going on without any diminution of the E.M.F. in the battery.

If the speed of the prime mover could be kept absolutely constant with varying loads, then we could obtain an ideal regulation by means of a dynamo having an infinitely small internal resistance, so that this dynamo, and not the accumulator, can supply all the extra current required by additional lamps. The characteristic curve of such an ideal shunt dynamo would be a straight, horizontal line, since its E.M.F. must be constant, at a given speed, whilst the current may be varied *ad libitum*. Unfortunately, such a dynamo would not suit an accumulator whose counter E.M.F. is 20 per cent. higher at the completion of the charge than at the commencement; the current rate would naturally fluctuate between very wide limits with the least variations of the counter E.M.F. of the cells. Thus with a shunt dynamo having an armature of an infinitely small resistance joined to an accumulator of extremely large capacity, we can obtain in the lamp circuit any amount of current at a constant potential, assuming an absolutely constant speed. An almost imperceptible diminution of speed, however, would lead to disastrous results in so far as the battery whose E.M.F. balanced that of the dynamo so nearly, would then discharge itself through the latter and drive it as a motor which in its turn will assist the prime mover for a moment until its velocity rises and overcomes the counter force. A small per cent. variation in speed will render such a method of regulation as defective in practice as it is perfect in theory.

In the other extreme case, again, of a shunt machine whose armature has a very high resistance, the speed may vary considerably without seriously affecting the E.M.F., but as soon as we increase the current through the lamp circuit the dynamo E.M.F. drops, the excess of current demanded has to be supplied by the accumulator alone, with the result of a general lowering of potential throughout the circuit. The characteristic curve of this dynamo approaches a vertical line. Between these extreme cases we may, however, find some happy medium which will give us the key to the solution of a difficult problem. To facilitate description we have constructed characteristic curves of two dynamos with which actual experiments were made. Neither of these approaches the ideals set forth in the preceding argument, yet both are employed in installations which have proved successful. We have drawn the *external characteristics* only with the ampères measured in the external circuit, the volts between the

terminals, and both plotted as shown on diagram fig. 7. The steeper curve refers to a Siemens $SD_2$ dynamo, whose armature resistance was ·32 of an ohm, and which ran at 1,380 revolutions per minute. The more horizontal characteristic curve represents the conditions observed by running an Edison (old L type) dynamo at 915 revolutions; the armature resistance of this, taken between opposite brushes, measured ·066 of an ohm. For the purpose of comparison we take the points of similarity in each, using the differences of potential within the limits of 135·3 and 126·1 volts.

To avoid complications we have omitted the *internal characteristics* of these shunt machines, but we may state that the current through the shunt varied from 6·8 to 5·8 in the Siemens, and from 7·5 to 6·8 ampères in the Edison, within the potential extremes of 135·3 and 126·1 volts respectively.

speed. Supposing we know the lowest number of revolutions the engine would make with a maximum load, we can gear the dynamo accordingly; if, for instance, we wish to charge the accumulator at the rate of 32 ampères with a minimum E.M.F. of 134·8 volts then this Siemens machine must have a minimum speed of 1,380 revolutions per minute. Any augmentation in speed will have the effect of increasing the current in almost the same ratio as the E.M.F. This ratio would be exactly the same if the angle, which the curve makes with the horizontal, were one of 45°.

In the case of the Edison dynamo, the slightest changes of the E.M.F. cause a very great fluctuation of the current rate, consequently with this machine we should have to provide a far more constant engine speed.

The present example of a Siemens dynamo will be

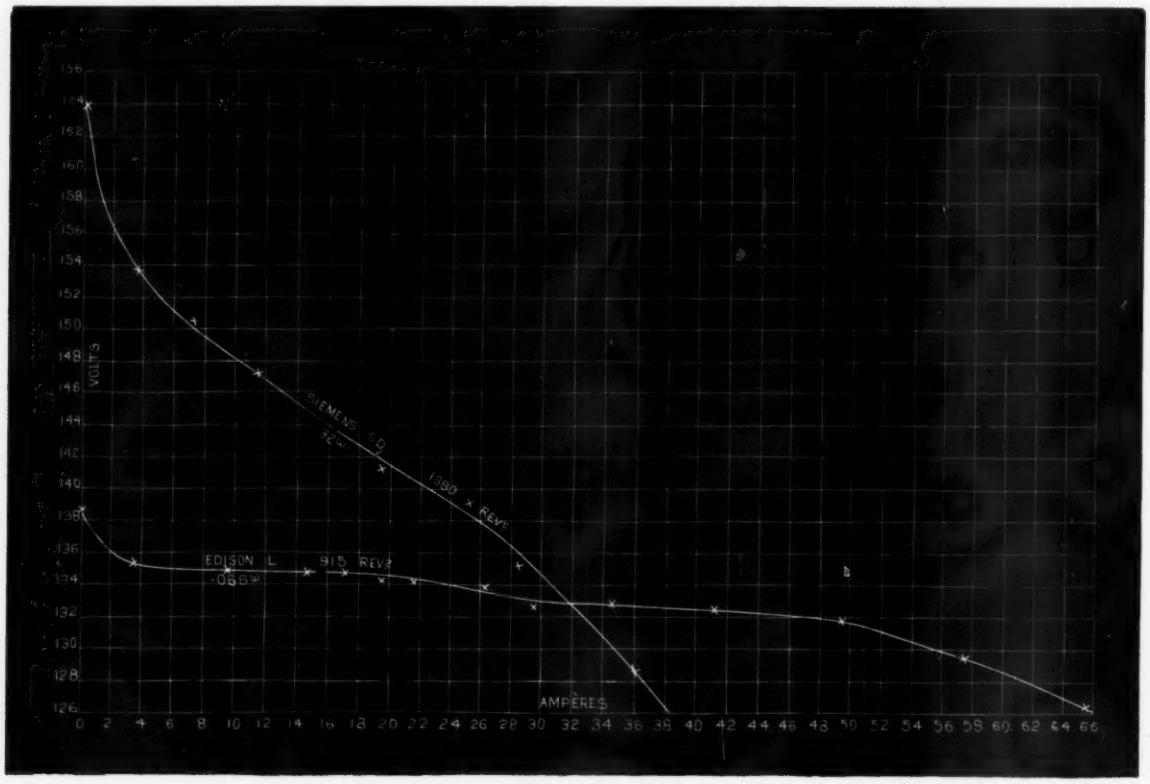


FIG. 6.

The curves of these widely different dynamos, it will be seen, meet at one point only, where each furnishes a current of 32 ampères with 134·8 volts; from this intersecting point the characteristics diverge above and below at an angle of about 37°. With a difference of potential of 126·1 volts the Siemens dynamo gave 38·3 ampères, and the Edison 65·8 ampères; with 135·3 volts the former furnished a current of 28·3 and the latter 3·5 ampères. The currents, therefore, in the one fluctuated only to the extent of 10 ampères, whilst that of the other differed by 62·3 ampères, within the limits of E.M.F's indicated; and these limits would represent, with a battery of 55 cells in series, a variation of from 2·29 to 2·46 volts per cell; just enough to overcome the counter E.M.F. of the accumulator when partially and fully charged. (*Vide* curve, fig. 6, page 319, *ante*.)

No current passed through the external circuits when the E.M.F. of the Siemens dynamo rose to 164 volts and that of the Edison to 138·3 volts, both working at their normal speed.

It is evident that the machine with the steepest characteristic curve will be the most suitable to work in conjunction with an engine having an irregular

found most suitable for an installation where the accumulator can be charged all day and furnishes a large current for a few hours in the evening; whether both are working in conjunction or not, the cells will have to supply the bulk of the current, since the dynamo current is limited. The Edison machine, on the other hand, if used with the same accumulator, will allow of a much greater margin in the current supply provided that there is ample power to be got out of an engine with a constant speed.

Regulation in the one case is effected by means of an accumulator whose capacity is large in comparison with the power of the dynamo, and in the other case the dynamo supplies the excess of current which the accumulator is incapable of supplying without loss of potential. In any case, therefore, the characteristic of the dynamo has to be determined with due reference to the nature of the engine which furnishes the motive power. The generally accepted analogy between an electric accumulator and a hydraulic accumulator, or a gasometer, as the case may be, is only true within certain limits, and we shall endeavour to consider these presently.

(*To be continued.*)

## THE PRACTICE OF DYNAMO DESIGN.

A SERIES of papers on the above, from the pen of Mr. Guy C. Fricker, is appearing in the columns of our esteemed contemporary the *Electrician*. In these papers we have in the formulæ a degree of simplicity hitherto unattained, as witness, for instance, the expression for the radius of the armature core where

$$R = 3{\cdot}6\left[\frac{E^2 C^2 (q + p + 2\beta).}{\rho\beta(\mu p q \gamma n P M)^2 (1 - p - \beta)\{2(q + p) - q p - p^2\}}\right]^{\frac{1}{4}}.$$

We can sympathise with dynamo men in the expressions of surprise and regret to which they will give utterance when this remarkable formula meets their sight. Over the hundreds of dynamos constructed without its aid they will weep tears of remorse and sigh in unspeakable regrets over the hours lost in applying a homely but unscientific foot-rule for radii finding. If we are not mistaken, the new method can be explained by the help of an analogy. In the practice of modern shipbuilding it might be possible by a formula more or less involved to express in terms of the steam pressure the number of passengers which the vessel is capable of carrying. By a further algebraic development—simplicity itself—the area of the piston rods might be accurately expressed as a function of the number thus found. Manifestly an expression so derived for the latter quantity would be of much greater service than a simpler expression in terms of the steam pressure and cylinder area, and no shipbuilder would hesitate to adopt the former in preference to the latter. In dynamo designing the indirect method should be similarly applied, and the more constants, coefficients and variables we can cram into a formula the more serviceable does it obviously become to the practical man. For this reason Mr. Fricker expresses the radius of the armature core in terms of "everything else," and this is, we repeat, the consummation of dynamo designing.

The formula will doubtless be used by every maker, as the core radius can now be found by the mere shuffling and cutting once or twice of a round dozen or so of symbols.

## THE DISTRIBUTION OF ELECTRICITY BY SECONDARY GENERATORS.

AT the monthly meeting of the American Institute of Electrical Engineers, on March 15th, the president, Mr. Frank L. Pope, opened the discussion of the topic of the evening.

The PRESIDENT: The subject for discussion this evening is the distribution of electricity by secondary generators. As you all know, this matter of distribution of electricity for lighting by induction apparatus, variously called secondary generators, transformers, converters, &c., is attracting a great deal of attention at the present time, although it is not a particularly new thing, having been in operation in one form or another pretty constantly since the early part of 1883; and yet it is only quite recently that it has been brought into what may be called a commercial shape. Very many of you are doubtless aware that something over two years ago I was commissioned by Mr. Westinghouse, of Pittsburg, now the president of the Westinghouse Electric Company, to go over to Europe and make an examination of this system and to purchase some of the leading patents on it for use in this country. Mr. Westinghouse had already made some experiments with it, and had become interested in it. So I went over to London in January, 1886, and I had the pleasure of seeing there an installation of some 2,500 lights working on the Gaulard and Gibbs system, which at that time was the only important installation that had been made. I saw there were great possibilities in the system, although it was not worked out practically at all—not worked out as we would work it out in this country by any means—and I was so well satisfied with the results that had been already attained, and of the possible results which we could get when we put our young men on it in this country, that I closed the purchase of the Gaulard & Gibbs patents for America, and brought them with me. Up to that time the matter does not seem to have attracted very much attention in this country, but during the past year a great deal of work has been done, and it seems now to have a great future before it. Theoretically, it is a system of the utmost interest. There are a great many novel points in it—novel in the sense that they have not been worked out practically. The action of the induction coil is a great mystery to a great many people, and not any too well understood by the best of us.

Dr. MOSES said: In the secondary system at present, electricity is distributed in alternating currents. The production and distribution of alternating currents is so simple a matter that the very first dynamo machine ever made was constructed on that principle. I recollect when Count du Moncel told me of the consternation with which the people who were interested in the Alliance machine came to him one day, and said, "The thing won't decompose water," for which purpose it was being made. "Well," he said, "I don't see any other way to do than to make it decompose water by turning it into a machine with currents of one direction, but if it were my affair I would leave it an alternating machine. Why not use the current at once for making light, instead of decomposing water with it in order to get light from the recomposition of its elements?" It was a very unfortunate thing that the alternating current machine did not decompose water, because we would have been about 20 years further in advance in the application of electrical science. That was the quietus of the alternating current machine for the time being. Well, they made a continuous current machine that decomposed water; but soon found they could make light a great deal cheaper by that alternating current machine than by combining hydrogen and oxygen. The first alternating current machine they made I have seen working near Havre in the lighthouse. It has never been stopped but once, and that was in order to put in a pillow block. Now, the alternating current machine is so simple that it is a wonder to me that it did not continue in general use. But then there came another matter to give it a set-back. M. Archereau discovered that a solenoid was a very excellent means of regulating a lamp. You could not use the alternating current with that. Therefore, the whole stream of invention ran into the channel of continuous current machines, and from that moment continuous current machines were universally studied because they could operate the regulating device of the ordinary solenoid arc lamp, and as the arc light business was the great one by which electricity was going to be built up as the power for general use, practical continuous current machines were invented and generally adopted. When a thing once gets on the ways, sliding down like a 10,000 ton ship, you cannot stop it. The invention of the Jablochkoff candle gave another stimulus to the alternating current machine, but popular prejudice, excited by the death of a careless sailor on a Russian royal yacht, caused its almost total abandonment for use in electric lighting, and finally the introduction of incandescent lighting on a great scale on continuous current circuits made it disappear entirely from use. But now the alternating current machine has taken a new and grand departure, because we find that you can only distribute currents by secondary generators where they are alternating in their character. Therefore, the alternating current machine has to be introduced, and its great advantages, which were hidden simply because they were not needed in the beginning, have come to the front, and it will be adapted to all kinds of distribution of electrical power. That sounds like a pretty broad statement when we know that motors are to be run on continuous current circuits. But what is the difficulty if you have got an alternating current machine that sends its current to and fro? Why, usually you send it to and fro through the same point. You can send it *to* there; and you can send it *fro* here, and you can have all the continuous current you please on the one side and all the continuous current you please on the other side. So that an alternating current machine can be made a continuous current one, and you can adapt the alternating current machine to any of the uses to which a continuous current machine is now applied. To come to the point, I would say that the practical application of this thing has been demonstrated to my satisfaction, and that is something that means to me a good deal. I think that alternating currents used from secondary generators are going to drive all the small electric appliances for the distribution of power that are now used. Secondary generation is bringing about a change that is going to result finally in a commercial revolution. We will find currents distributed abroad in every direction, in every house, and we will have power at command for all purposes, just as we have it here at this moment in the incandescent lights around us; and that is all going to come about through this alternating distribution.

Dr. MOSES then referred to his visit to Pittsburgh where he had seen the system in practical operation. He spoke also of the similar station in Milan, Italy; he also quoted the opinion of Prof. Colombo regarding the high efficiency of the secondary generator system.

Capt. MICHAELIS then gave an account of his visit to Greensburgh, Pa., where alternating currents are distributed and transformers used. He found a prosperous and paying station distributing about 650 lights.

Prof. ELIHU THOMSON: The subject for discussion this evening is one of very great and growing importance. I am forced to recall a little experiment I made in illustration of the reversibility of an induction coil, before the Franklin Institute of Philadelphia in 1877. I then gave a course of lectures on electricity and the main principle put forth was that electricity of all kinds and characters—statical, dynamical, or whatever you choose to name it—was really the same thing and of exactly the same nature, differing only in potential pressure or electromotive force and volume. I exhibited, of course, in illustration of this, a Ruhmkorff coil, and while preparing the lecture it struck me that it would be a very pretty experiment if I could reverse the process, and instead of getting discharges which would have the statical

properties, I should take my Leyden jars and put the Leyden jar discharge through the fine wire of the Ruhmkorff and see what I would get in the primary circuit. This I did, and I was somewhat astonished at the volume of current which seemed to come out of the primary. I expected, of course, to get a heavy current. I knew perfectly well that the Ruhmkorff coil must be reversible, but I was surprised to see the energy that the Leyden jar discharge displayed when it was turned into what was then called the quantity current; the ends of the primary wire being brought together, there was a bright green flash, and after repeating the experiment once or twice the wires actually stuck firmly together. It was with difficulty that I separated them. They bent a little, and with a good pull they separated. There was a sufficient proof of the reversibility of the induction coil. The capacity of the Leyden jars was three gallons. The spark which fused the coil was an inch and a quarter long. Another fact came out in the experiment which was very striking. We are all familiar with the loud snap produced by the Leyden jar discharge and the bright flash. I was surprised to see, however, that the spark which struck through the coil was exactly like the Ruhmkorff spark. It occupied a time. It did not go with that sudden energy with which the Leyden jar discharged, but it went through with the appearance of the ordinary Ruhmkorff spark. This thinning out was no doubt due to the retardation which occurred in that discharge. This experiment was repeated, and the primary wire was also connected with a galvanometer of very coarse wire and the needle went right up solidly to the stop at every Leyden jar discharge. At that time I thought it must be perfectly well known to anybody that would dwell upon the conditions. This experiment left its impressions on my mind, and my recent experiments in welding by electricity are the outgrowth, as I see it, of that little experiment of the Leyden jar discharge sent through the Ruhmkorff coil. When engaged in electric lighting, I found it necessary in the construction of dynamos to make good joints on wire, and it was with some difficulty that really good joints were made. Our wire in the early days was only obtainable in about fifty pound lengths of copper and some of our coils required about 300 pounds, so that we had to make some five to six joints in every coil. In thinking the matter over, it struck me that electricity would do that work, but the thing was to get the currents. They were necessarily enormous. They were necessarily much larger than we had been accustomed to deal with. Arc light currents and incandescent currents in those days probably did not in any case give more than two or three hundred or four or five hundred ampères. The induction coil experiment, however, seemed to point out the way, and I designed at that time an apparatus which I thought would answer the purpose, but I was compelled to lay the designs away and had no time to develop it further. Taking it up, finally, however, I tried the experiment of building a small alternating machine and putting it on to a moderately fine wire, which was to be the primary, and taking a very coarse and heavy secondary, so that the potential of the currents generated in the secondary might not exceed one or two volts at the most, but could run up to thousands of ampères. The first experiments made with the apparatus were entirely successful in joining copper, iron, steel, &c., the wires being a moderate size, of course. I mention these facts simply to show their connection with the subject under discussion. We have there probably the extremest case of what we call conversion from high potential to low potential. Dr. Moses has mentioned the fact that no commutators are needed on the alternator, and I can say that it was really fortunate for us in welding operations that there are none, because our currents are varied enormously in a very short time. We start out with a piece of metal that probably is only a few square mils in section, and with the same apparatus we run up to an inch or more in diameter, and if we had a commutator on the machine that amounted to anything, we, of course, would have to make a new adjustment each time, and every time the current changed greatly it would be likely to tear out the metal and throw it around, because we run under strong conditions while we are putting on the heaviest current. As to the distribution of incandescent lights by the induction coil, I may say that in the latter part of 1878 and 1879, in company with Professor Houston, I made some experiments with the design of using a little arc lamp for distribution. It is called a vibrating lamp. The electrodes were vibrated to and from each other, and we used induction coils to give the impulses to vibrate the carbons and also to supply the currents to the little lamps. The incandescent lamp in those days was unknown. There was no such thing as an incandescent lamp in 1878, at the time the experiment was made, but gradually the incandescent lamp became known and induction began to attract some notice in regard to distribution. Now, it always has appeared to me that there never should be any doubts as to the efficiency of a good induction coil; that is, that the losses in an induction coil never could amount to a great deal if it were properly made. What is a dynamo machine but an induction coil after all? It is a revolving induction coil. We have what might be called the primary circuit in the field magnets giving the magnetism, but instead of reversing the current in the field magnets we reverse the position of the secondary; that is, we turn it over to get our impulses; that is, not that those impulses come out as gushes of current or waves, but if we turn over portions of the armature by degrees we get a continuous flow of current, and if the dynamo can be made to go to an efficiency of 90 per cent., why cannot an induction coil be made to go to an efficiency of 95 per cent.? We use a reverse primary. We do not reverse the position of our armature in relation to the magnetic field developed by the field magnets, but we make our field magnets reverse and divide them up by laminations or by making them of fine iron wire. Put plenty of iron in the coil and the losses should not be any more in making the conversion, so far as Foucault currents or local currents in the iron are concerned, than they are in a well constructed laminated armature. In regard to the use of alternating currents, let us see if there is any possible objection to the use of them. There has been a great prejudice against alternating currents (which I think is gradually being removed) on account of the very fact that they alternate, and that they involve, therefore, the danger of severe shocks. We have learned to look upon alternating currents, somehow, with considerable dread, on account of the fact that the current goes this way and that.

Prof. THOMSON then detailed how he had accidentally taken the alternating current of many thousand volts from an induction coil operating a Jablochkoff kaolin lamp, and without serious consequences. He continued:—The other day, in experimenting with alternating currents in which the maximum difference of potential existing was about 1,300 volts, capable of equalling in potential a good circuit of arc lamps, I happened to touch a post and to bring my hand to another post, and I felt something or other queer and drew away. The result was I got a little blister on the hand, but that was all. If I had short circuited an arc current of the same power, I would not have got away so easily. I should have come away with my hand very badly burned; but, as it was, the alternating current did not follow just as I ruptured the contact. That is a feature of the alternating currents which is very good in rendering them safe. Let us see if we can find any reason for it. The alternating currents rise and they come down to zero and they reverse and so on; but there is a line along the middle of the curve which is neutral. Now, unless the materials forming contact are of very high volatility, the spark formed is very apt to be extinguished on that reversing point. At the same time there is another fact which would cause the arc to be extinguished, and that is the effects of self-induction or extra currents in prolonging the discharge are nothing. Take an alternating current, and its discharge cannot follow up anything that has short circuited the apparatus. It would seem from these experiences that we need not have any great fear of the danger arising from alternating currents. It is very doubtful indeed whether the fluctuations in the arc light current are not quite as great, and whether the injury to a person short circuiting an arc light current is not due as much to abrupt changes in the current as to the mere current itself. That is, an arc light current does not usually have the character of an even wave—a smooth wave. There are segments in the commutator acting just like so many break pieces, and whatever effect they produce is produced in an inconceivably short space of time, and if we could map the wave so produced it would be very irregular and jerky. No doubt every one has tried the effect of a shock from a magneto-electric machine. Every one knows that if the speed is regular and the contacts are good he can stand a pretty fair shock; but let it be irregular, let some faulty condition occur, and first give him a shock and then ease up a little and give him some more, and it will be found to be very exhausting indeed. In the one case he knows what to expect and is prepared for it; in the other he does not and is not prepared for it. This brings us up to the consideration of the nature of the alternating current itself. It is a rhythmic wave, and it can be made just so perfect and so smooth, that at any portion of the wave the change of current is quite slight. There is not a sudden jump of current or a sudden action, which, though it occupy only the 100-thousandth part of a second will make a considerable difference in the wave. Let us see whether we have any facts which would lead us to think that there is a difference of that kind between the ordinary arc light and the alternating current. In working on this alternating current matter, it occurred to us that there might be some difficulty in running lines on account of telephone interference. Injunctions might be served on anybody running lines if the alternating currents had a bad effect on the telephone lines. To test that matter we ran parallel lines to both it and the arc light circuit, using about the same current on each, and I was surprised at the results. Prof. Thomson then described some experiments which showed that the effect on telephone wires of the alternating current was far less than that of the continuous current. The strongest effect produced by the alternating current was a musical note in the telephone, which did not seriously interfere with ease of communication, whereas the continuous current gave a rattling and scraping sound.

Mr. WETZLER: It occurs to me that the point of utilising a high potential current of low quantity for the purpose of facilitating distribution is one which can be looked upon in another light; that is to say, we may use a continuous current and interrupt it. That system has been brought out recently, and, it seems to me, presents some quite interesting points. The arc current to-day may be considered in that light. We have there the conditions of a high potential circuit with low quantity. Why may we not by suitable apparatus break that current at certain points, utilise it to put our secondary generators in operation and then continue it on; or, if you will, break it directly at a central station and use the broken continuous current (if you might so call it) in the same way as you would the alternating current? We have all heard of the advantages and also of some disadvantages of the secondary generator system in this country as presented here. I think it may interest the members to hear the opinions of some foreign electricians on this subject. Dr. Moses has given us Prof. Colombo's opinion on that, which is very favourable, and I think, for the sake of discussion, that some of the unfavourable opinions might be brought

forward. In a pamphlet recently issued by them, Siemens and Halske, of Berlin, flatly contradict the utility of the secondary generator system. They say in effect that isolated installations, even large ones, may be practicable on this system, as witness some of the installations already existing in Europe. These they consider, however, only isolated systems, though on a large scale. For a general distribution they claim that the thing is not feasible, in fact, is not as good as the ordinary two-wire direct distribution. I must say this, however, that they premise that all distribution must be done by underground conductors. They say that if you want to distribute generally, an overhead system is out of the question; that there are too many uncertainties in connection with it and that you must go underground. Now they figure up that to put underground a high potential system in which, instead of using 100 volts ordinarily, you use 2,000 volts, with a corresponding reduction in copper, the money you save and interest on that copper will not make a difference of 1 per cent. in your expense account. That is to say, that in the largest underground cables, properly insulated, the value of the copper contained in them does not exceed 15 per cent. of their cost, and in smaller cables this ratio is even less. To this must be added the fact that the transformers necessary constitute an item which, together with the above, almost balances the saving in copper obtained by using high potentials. Then they bring out the argument against the alternating current, that it is not available for motors, which they consider a valuable adjunct for electrical distribution. How far these objections are good in an overhead system, or how far they can be removed, remains to be seen. I think they can be removed, if they are not removed already. But such is the opinion of Siemens and Halske, which has some weight, whatever their motives may be, and they deprecate the secondary generator system, for the reason that they say it is not suited for general distribution, which must be effected by underground wires. They also say that you cannot regulate the secondary generator within the limits that must be obtained to give satisfactory incandescent lighting. They say that if a secondary generator will only regulate within 4 per cent. when turning on all the light, that that is not sufficient, and that secondary generators cannot regulate closer than 4 per cent. I believe that that objection can be removed if it exists.

The PRESIDENT: I would say in respect to one point raised by Mr. Siemens, that it is not quite clear to me, since a secondary generator is nothing more than a dynamo, why it is not possible to regulate with a generator as it is with the direct distribution.

Mr. WETZLER: Siemens and Halske, in their pamphlet, criticise other systems, but they say that they have got something of their own that will answer.

Mr. C. O. MAILLOUX referred to the analogy of action in the dynamo and the induction coil, and said that theory would show that the latter ought to be a more efficient device, as it had practically no dead wire, and that hence the electromotive force developed per unit length of wire ought to be greater. He inquired if any experiments had been made on that point. He also referred to the fact that the transformer was liable to acquire a static charge which might discharge itself through a person coming in contact with the transformer.

Prof. THOMSON: I will say that in regard to the efficiency of the wire of the induction coil that it is certainly possible to produce a higher electromotive force in a wire subject to induction than it is possible to produce in a dynamo armature. The reason, however, may not be so clear. It is practically a greater speed that does the work; that is, the alternations may be made at various rates; we can have 10,000 alternations per minute or we can have 15,000 or 20,000, and it would naturally result that if the field of the induction coil should be changed 20,000 times and to the same degree, that at that rate of alternation a certain length of wire in the secondary should give out twice the electromotive force that it does when subjected to 10,000; and also that the primary wire should kick back, as we may term it, with a double kick, or in

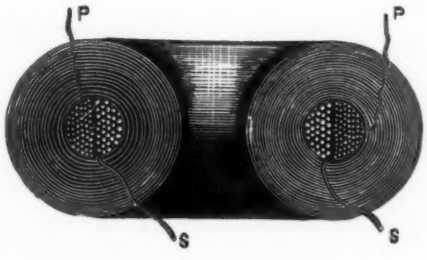


FIG. 1

other words, be able to hold back an electromotive force twice as great. The question arises: Is that secondary wire, S (fig. 1), constantly in the magnetic field? It is not; that is a certain fact. The magnetic field is around it and does not show any polarity whatever and the secondary wire is not in the field; but the secondary wire was in the field at the moment that the magnetisation was going on. Consequently, the secondary wire gives out a current when the primary wire, P, is beginning to take the current up to the maximum which it may reach. To make that plain, we will separate the wires a little. We will call it a single wire. That will be the primary, P (fig. 2); this the secondary, S. Now, what will be the effect if we pass a current through this wire, P? It will cause circular magnetism around it, and that circular magnetism will emanate in all directions quickly, and stop when it reaches the best medium; that is, when it gets into the iron. That is my view of the action. I do not know that it has been adopted at all, but I look at it in that way, that the wire conveying a current gives out, as it were, shells of magnetism rapidly expanding to large dimensions. But, if they meet with such a good atmosphere as iron, they condense themselves in the iron. What does the secondary do? If it has an open circuit, it does nothing. If it has a closed circuit it develops a current. I say when it has an open circuit it does nothing; I am not strictly correct there. It develops only an electromotive force in the two ends of the secondary, which, if it gets a circuit to produce a current over, will produce that current. But the very fact of the passage of the current in the secondary tends to produce just the

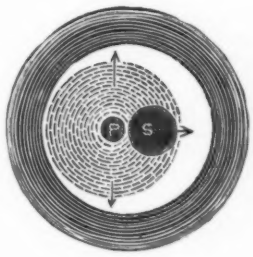


FIG. 2.

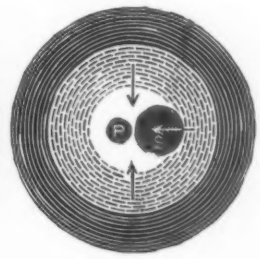


FIG. 2A.

opposite magnetisation, fig. 2A; that is, as these lines pass across, the secondary would oppose them by producing a field of its own. But if the primary is much the stronger, then the secondary has not got any chance to have any field of its own, and it kicks all the harder for that reason; that is, it gives out more current just because it cannot have its own way. As to the actual practice in regard to the length of wire, I must, before stating what I know to be the case in regard to such action, see what we have in the alternating current. What have we? We have an increasing

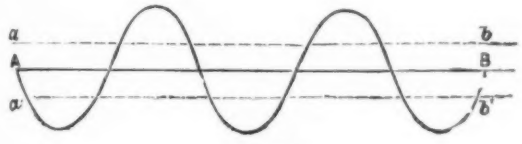


FIG. 3.

current from zero up to maximum. (Fig 3.) And following the current down to the zero and oppositely up to a similar opposite maximum, and so on through. What volts shall we give to that current? Shall it be the distance between the top and bottom of the wave, or shall it be the average of positions on the wave, $a, a'$? Now, it is evident that in running an incandescent lamp it is not this electromotive force ($a, a'$) that is present. When you put a 75-volt lamp on such a current, you do not take that; it must be higher than 75 volts, because this electromotive force which would produce the current does not last all the time. It is probably nearer 150 volts. The maximum differences of electromotive force are probably nearer 150 volts, and we have a point here, $a$, where there is not any difference. We then take the average, $a, a'$, as the average volts. You see that this gives us another view of the electromotive force developed in a coil. If we take the maximum difference, then this wire is developing more than it appears to develop per foot or per number of feet. Now, in actual experiments with alternations of very nearly 10,000, the number of inches to develop a volt by such an arrangement as fig. 1 will be somewhere between six and twelve in the primary and secondary. But the singular part of it is—supposing we take the figure at nine inches with rather slow alternations—our nine inches develop a volt in either. What does that mean? Why, it means that four and a half inches develop a volt of maximum difference; that is, taking that point from the highest point in the wave to the opposite highest point, it is a good deal higher than the average, $a, a'$. I cannot say just now that it would be as exactly one to two; because that would depend upon the shape of the wave. Taking an extreme case it might be an irregular wave (fig. 4) and the average of the electromotive force in that case would be lower than in the regular wave. The point in regard to induction in telephones is also made clear by studying a moment the action that occurs. From point $a$ to point $a'$ lies a certain change in the phase, and so all along. The curve is quite gradual, and if the diaphragm of the receiving instruments gets an induction which is gradual, it will not give a

blow hard enough on the ear to be heard distinctly; but if the wave should be of the character of this (fig. 5), then every one of these little jumps will cause the diaphragm to hit the air a blow, and that would be heard on the drum of the ear. In relation to the static charge, I do not attach as much importance to that as would at first seem might be attached to it, for the reason that the actual amount of condensing surface in the induction coil is not a very great amount after all. It is quite possible to take rapidly alternating discharges from a little magneto-electric machine which may represent far more current energy than the static charge or discharge of a moderate sized induction coil, although it is possible that with induction coils working hundreds of lights there might be a stinging shock obtained by touching the wire of the induction coil. The static charge does certainly exist, but it

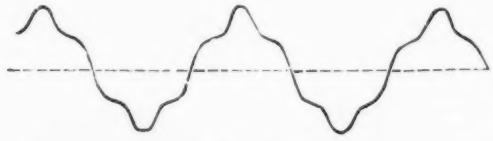

FIG. 4.

represents very little current, so that a person may take it without any inconvenience. A person standing on an insulated stool can have 10-inch sparks drawn from him and he does not mind it at all. He can charge his body through the potential of many thousands of volts, and he can discharge that potential from his knuckles without any other feeling than a little shock in the arm. I have taken by accident discharges from Leyden jars—say three gallon jars at an inch and a half of striking distance—and all that I felt was a violent shock which was over in a moment. It may benumb you a little, but it does not amount to anything. As to another source of danger in the use of induction coils, such an accident as this may happen at any time. By moisture or by faulty construction or some other such cause the primary may become connected with the secondary or be so close to it as to cause a leak from one to the other. No particular danger should result from that alone, although there would be a more vigorous discharge, statical in character from such a connected secondary, because on the one side of the line you would have a rather long line, and at this one point you would be able to get the discharge of your whole line in rapid succession. But the chief danger in such

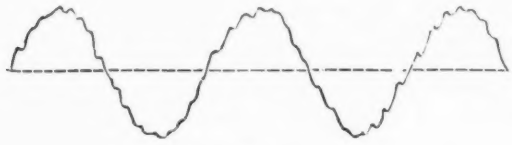

FIG. 5.

a case is the formation of a second contact to ground. The induction coil, which at the same time had a contact to the primary line, would necessarily take the potential of that line, and we will suppose that is on the other side of the line from the grounded portion. Now, a person may go to the lamp under those conditions and his fixture might be near a metal object, it might be connected by moisture; he might stand on the moist floor, and the result would be the current would come down through his body and he would be subjected to the full potential, and there is no doubt that if he should be foolish enough to stay there he would have to stay there until somebody took him away. A man when he is shocked generally drops away from the thing that shocks him; but he may be, as we term it, "hung up;" that is, he cannot let go, and that is undoubtedly the reason why accidents happen in arc light distribution. If a man can get away at once, even such a potential as 2,000 or 3,000 volts will not kill him, as we have had plenty of experience to prove. To avoid such dangers in alternating current lines we provide a very simple means, we ground our secondary. If the insulation between the primary and secondary is as good as it ought to be at all times, the grounding of the secondary will not hurt anything, that is certain. What then occurs? If the man takes hold of the secondary wire and touches a radiator connected with the ground or a water pipe, he is already shunted by a good conductor and he cannot get anything to hurt him. Put this ground connection to your steam radiator or water pipe. That addition to the system would save us from all shocks, but it would introduce another element of irregularity and danger; that is, it would provoke contacts to the secondary line; but, nevertheless, if a contact does occur, cut your line off altogether by putting a fusible plug in the circuit leading to the primary, so that if there is any diversion of current through to the secondary and to ground, the plug will blow out. There is another danger, of course, in having this ground connection, and that is the danger of atmospheric discharges, lightning, &c. That, however, can be avoided by making the insulation here about the primary coil heavy, and in fact separating the wires by an air space, and then putting near the primary line where it enters the building, or in any convenient point, an ordinary lightning arrester, in which the spaces between the line and the conductor to ground are so small that an atmospheric discharge will seek the ground through that and not through this. Of course it would be necessary in running such a system to test it for grounds just as lines are tested to-day.

Mr. W. LEE CHURCH: My proper office here would naturally be to defend the secondary system against attack, but I find that there has been no serious objection raised. With reference to the opinion of Dr. Siemens, I have only to say this, that I should reply to his criticisms by subscribing my fair share toward paying his passage to this country to see the thing done. I was recently at Daly's Theatre and witnessed that charming production of Shakespeare's, "The Taming of the Shrew," and I noticed that Petruchio insisted that that was the sun, in defiance of the fact that the moon was shining; and it strikes me as ridiculous (if I may be allowed to couple that term in connection with so distinguished a man as Dr. Siemens) to state that the secondary converters will not govern within better than a range of 4 per cent., in defiance of the fact that the company with which I am associated is operating these converters commercially, deriving its pay from the plants, and the whole thing is reduced to an ordinary matter of fact. The variation is absolutely not appreciable by any of the instruments that we can bring to bear upon it outside of the laboratory. We are putting in 100 volts and taking out better than 98 in selling them to people and getting our pay for them. I contend that the final touchstone in the eye of the practical man, and more important in the eye of the man to whom we sell, is, Can I take this thing, disregarding the whyness, and simply secure the result and put it in my vest pocket? The question has also been raised as to whether the distribution upon this high potential system coupled with underground circuits might not be essentially as bad as on the ordinary multiple, and eat itself up in capital before going out to a certain distance. Let us look at it from the commercial standpoint. Copper is not the sole element of economy by any means. In fact, I think there has been an injustice done to the secondary system by insisting that its prime usefulness lay in the reduction of the first cost of primary wiring. That is one way to put it; I think it is the least forcible way. As I judge of it, from daily contact with it commercially, the usefulness of this system lies in simply extending your business from a given point to the remotest point possible. We have certain fixed expenses—I am now talking to you from the standpoint of the man with whom I deal—these expenses consisting of salary accounts and investments in building and interests and depreciations and what not. Now I wish to thin out that expense as far as possible and to make it bring me in a large amount of business. Therefore, if it were true, which, permit me to state, it is not, that the increase of the cost of copper was in any such ratio as has been alluded to by Dr. Siemens, it still would leave untouched the fact of rendering the other fixed expenses of the installation available for the increase of business. That fact has been commercially proved with us beyond peradventure. The use of the generator system—high potential system—permits the running of wires on a very small percentage of drop of E.M.F. With the ordinary multiple arc system and low potential our copper is so much anyhow that we have got to sacrifice ten or fifteen per cent. of drop to secure a reasonable amount of copper at all. But this converter system enables us to run upon a two per cent. loss in the primary coil, and that saving is a merchantable article in some form in any way you are of a mind to figure it up. Furthermore it has an enormous effect upon the light of the lamps, which is another commercial question. The secondary system enables you to maintain an almost absolutely uniform potential all over your line. Thus I might drift along, touching upon a host of points which are in no sense scientific, and yet seem to me to carry much weight if we consider the question in its practical and every day aspect. I am pleased to say that so far as our work has progressed—and we are treating it entirely on a commercial basis—there has seemed to result no serious difficulty that we have had to overcome.

Mr. E. E. RICE inquired as to the effects of alternating currents on telephone lines.

The PRESIDENT, in reply, said that difficulty was experienced in London when the lines were first put up in the shape of a single

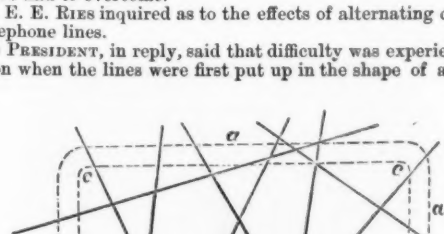


FIG. 6.

circuit, as *a a a*, fig. 6. But after arranging the lines so as to resemble a complete metallic circuit, *a a a, c c c*, the trouble was completely removed with telephone lines crossing in every direction.

Dr. MOSES: There were one or two points that Prof. Thomson referred to that are very interesting. He says if intercalated in these variations (see fig. 5) there were waves of small amplitude, that those might make a kind of tick upon the ear that would be audible. He will recall, perhaps, a remark that Prof. Tyndall made when he was once going on one of his excursions with a guide. He said to his companion, "What a deafening sound that is that I hear." The man said, "I do not hear anything at all." Professor Tyndall looked at the man in amazement. "You do not hear that sound," he said. "No," said the man, "I hear nothing." Well, it was a question of fact, and Tyndall had tried to explain it, and did explain it very reasonably by saying that his ear was tuned a little higher than the ear of his companion, and that the grasshoppers who were producing this fearful noise and had collected in great swarms in his neighbourhood—their note was of so high a pitch that his ear could hear it and his companion's could not. Now, if you calculate the variations that there would be in an ordinary alternating circuit it would amount to about 250 a second. 250 variations a second would make a very pleasant musical tone; but these small waves would be so small compared to the whole amplitude of the waves that they would be altogether inappreciable to the finest tuned ear. They would amount probably to 8,000 or 10,000 vibrations per second, which would be perfectly inaudible, so I doubt whether the rise and fall of the waves would produce that unpleasant sensation if it were only slightly interrupted. There is another point that I would like to call attention to with regard to what has been said. Mr. Church referred to running these wires overhead. I think that very serious consideration ought to be given there. While this underground commission is somewhat in confusion, a great deal of attention should be given to this fact, whether it is absolutely necessary for wires carrying alternating currents or currents of very high potential to go underground. I think there ought to be a distinction made. Although an alternating current may not injure a telephone, still it is not every current that is perfectly uniform. There may be breaks in it, and it might introduce some disturbance, and those things should be avoided. For that reason it would be well for the whole electric lighting interest, it seems to me, to call attention to the fact that it would be better to leave the air to the distribution of current for lighting and to take the earth for telegraphic and telephonic distribution and the distribution of power. There ought to be a dividing line there. Dr. Moses

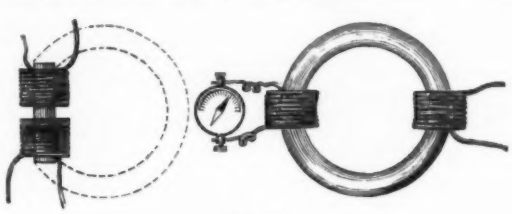

FIG. 7.

then referred to Faraday's first experiment in magneto-electric induction as the groundwork of the present secondary generator work, and drew the analogy, illustrated in fig. 7, between Faraday's coil and the modern induction coil.

Mr. MARTIN: I would like to ask Mr. Wright in regard to the line distribution of these converters. My friend Duncan, in Pittsburgh, is very well pleased with his secondary generator plant there, and stated to the Philadelphia convention that he had some of his converters on the poles, but said that in one or two cases he did not think it necessary to have it there but attached it to the building.

Mr. WRIGHT: At present my converters are on the poles. My lighting is scattered, and I have not a large number of converters, but I have more than is sufficient for my capacity. They are sometimes about four or five poles apart, a great deal depending upon the disposition of the lighting. Of course I may have occasion to place my converters in the interiors of buildings in some cases, but generally outside the buildings. I propose in Plainfield, in the residence portion of the town, to run my branches from the sub mains into the central portions of the blocks. I forgot to mention that I am running in my station at 104 volts. My line is calculated in the business portion of the town for 1,500 lights. At present I am simply regulating by my station lights. I have had no trouble whatever with my armatures or converters.

Mr. MAILLOUX: I would like to have somebody tell me whether anything has been done to develop the application of the secondary transformers for distributing power in motors. Dr. Moses has told us that he could send one impulse *to* and the other *fro* in the same circuit. It would be interesting to know whether this to-and-fro matter is only theoretical, or whether it is practical and has been accomplished. I would also like to inquire whether in the event of a system of distribution by periodic impulses of one polarity on each circuit, the size of the transformer, and, to a certain extent, the method of its application would not need to be changed to conform to the different manner in which the energy would be distributed, because we shall have now energy being supplied by the circuit for only half the time, and of the energy so supplied we must store enough in the induction coil to maintain the supply during the other half. In other words, it must produce a certain magnetic reaction which will be sufficient to keep up the energy during the remaining half. I would also like to know what has been found in practice to be the difference in efficiency between the coils of the ordinary straight description and that of the circular form which is generally used in installations for distributing energy by means of transformers. I have had this question submitted to me lately on several occasions, and I was of the opinion that the difference in efficiency would not exceed two or three per cent. I would like to know whether any such data has been obtained from practice.

The PRESIDENT: I think that question which Mr. Mailloux speaks about was pretty thoroughly investigated by Professor Ferraris. It was something like this, that there was no particular difference in the coefficient of efficiencies, but there was a good deal less amount of iron and copper necessary to do the work with the closed core than with the open one.

Mr. MANSFIELD: The subject of the distribution of electricity for lighting purposes has been pretty well handled by means of the converters; but I fail just exactly to see of what use for motors the converter is. In the installation at Plainfield we have not such a great distance to annihilate, and all men who are engaged in the transmission of power are talking about annihilating space. Mr. Wright, I think, spoke of using the converter right in his own station. Now, I do not see that there would be any economy there over the direct system, unless when you go to a distance you want your alternating currents or your high potentials there, so as to annihilate the distance. You put your converters or transformers on so as to get the electromotive force down to a working basis, and with motors I presume that the same converters can be used. But I do not see just how the economy comes in in using the converters so near the station. In my opinion, a station established with the ordinary arc light potential in the middle of New York City, exactly in the centre of the longitudinal axis of the island, would quite easily handle the motor problem in the entire city, and even at a less potential than they are using on some of the arc light circuits. The question of danger is another question. But I think that can be simply answered by the fewness of the lives lost on the arc lighting circuits. So that, after all, perhaps right in the arc light circuit we motor men have a means for carrying on our business without interpolating converters.

Mr. WRIGHT: The last speaker made a remark in regard to a converter in the station. I can hardly light my station without converters, seeing that I have a 1,000 volt machine and my lamps are 100 volts, worked at a distance. My lines in Plainfield, at present, average about 5,000 feet from the station, and I am laying out one line which will be four miles from the station.

Prof. THOMSON: In regard to induction I may say that the system which is figured on the blackboard (fig. 6) has a double wire going out and returning, which is almost a necessity in the running of our plant. Almost all arc light circuits go and return on the same pole and the nearer the outgoing and returning wires are placed the better it will be. But as we cannot place them close together, we can do the next best thing, we can interchange their positions, cross and recross back. All that we have to do is to produce such a condition in the wirings as will not give an effective magnetic field which can act on the other wires. With the alternating current machine you can turn up and down a lamp without a loss of energy amounting to anything. Now that seems a surprising fact, but it is true. The lamp may be run just as you would a gas-burner; turn it down so that the filament is red, by a little attachment no bigger than my fist. It is simply the interposition of a very little coil—not an induction coil—sheathed in iron and with the capability of putting more or less wire into the circuit; in other words, setting up a counter electromotive force in the circuit will prevent the current going through the lamp, and will do that, not as a resistance in the lamp, but by throwing the electromotive force back on itself. That can be done to a single lamp or it can be done to a group of lamps. On the continuous current circuit there has been, and is, a continual strain after high volt lamps. It is almost regarded as unpractical to run any distance unless you take one hundred or one hundred and ten volt lamps, the highest that can be commercially made. The reason is that when you get beyond that the filament will almost sag by its own weight, and the one hundred volt lamps that are made to-day are generally of a low efficiency, compared to lamps of lower volts which will give exactly the same light. A fifty volt lamp, for example, can be made to use less energy than a one hundred volt lamp, and give the same light. As to the motor question I think that the alternating current motors can be made to run nearly as efficiently as continuous current motors, and with the saving of drop in the mains we can afford to run them less efficiently. It is not absolutely necessary to change the high potential current by an induction coil for the motor. If the motor is built to stand the potential in the main circuit there is no need of reducing the potential.

Mr. CHURCH: Except as a matter of personal safety.

Prof. THOMSON: That is all. But it seems to me that as the alternating current motor is an apparatus that has not got a commutator, necessarily, the machine may be boxed up and run with fair safety. The only difficulty about ruuning motors is getting them started. The fact is that if the impulse comes at a certain rate, unless the motor takes that impulse at the same rate, it will not start; that is, you must give it the speed first; you must put it in tune with the rest of the circuit by giving it the speed; then clap on the current and it will run at that speed absolutely. If you overload it you will draw it down and it will stop. Now I have in my possession a little machine which, put on an alternating current circuit, will start from the state of rest and run right up developing considerable power. That machine may not be as

efficient as the continuous current motor; but I can put that little motor on the same shaft with the larger alternating motor and give it the speed by that little motor. I thus have the whole thing under my control. I take off the load and current from the large motor and I put this little motor on, and when speed is reached throw the current on the larger and throw off the other. I am not at liberty to describe in full that arrangement. As yet it is not fully developed, but I hope before long to have it in such a shape that it can be fully discussed.

## LIGHTNING CONDUCTORS.

THE Town Council of Greenock having accepted the specifications of Principal Jamieson, of Glasgow, for the protection from lightning of the new municipal buildings, the work is now being carried out by Messrs. David Tosh and Sons, Greenock.

The main tower of the building, which rises about 260 feet above the street level, will have a main tape conductor 1 inch by $\frac{1}{8}$ inch, terminating in a copper band with six cone-shaped copper rods with screwed platinum points $\frac{1}{4}$ inch long and $\frac{3}{16}$ inch diameter. Around the base of the column there will be six similar points with platinum tips screwed hard into the cones. On each of the four turrets (120 feet high) towards the base of the main tower will be fixed four vertical points connected to a single copper band; the ornaments being similarly protected.

*Small Turrets, the Town Hall and Police Chambers.*—The four turrets, &c., which stand about 126 feet high, will be protected by a similar band in one continuous length without joint—with 14 vertical single points.

The roofs will be guarded by horizontal bands in connection with the main earth connectors. They will be in continuous lengths without joints, except where they are attached to the vertical bands, and there they bill be riveted or bolted, and where possible brazed.

The conductors will be in connection with any lead or metal on the roofs along which they pass. They are to be clamped down in all cases at distances not exceeding three or four feet by strong copper clamps or nails.

Test and joint boxes, neat, strong and well varnished, are to be used for testing the complete systems and the various earth connections. The joints must make perfect metallic contact when screwed together. The screws to be capable of taking in and binding a wire of not less than No. 16 Board of Trade S.W. gauge.

*Earth connections.*—At each of the four main earths advantage is to be taken, if possible, of the main iron water pipe system of the town and the conductor band is to be securely attached thereto.

Additional earth connection will be found by copper plates sunk outside the building, at not less than three feet under the surface of the ground in as damp a place as can be found, and surrounded with small ground gas coke, and on all sides to a depth of not less than four inches and well punned. The main conductor band will be thoroughly and well rivetted and brazed to the plate, which will also have about 30 copper nails through it on opposite sides.

The absolute resistance of the earth between each of the terminal points and its own or nearest earth, in the case of a water pipe, to be less than *two* ohms and in the case of the earth plate *four* ohms.

The absolute resistance of the whole system when joined up to all the earths should be less than *one* ohm from any point. The method of electrical testing is to be that described in pp. 182 and 183 in Messrs. Jamieson and Munro's "Pocket Book." It is estimated that about 2,100 feet of copper band will be used.

## ELECTRIC LIGHTING AT BOURNEMOUTH.

THANKS to the enterprise of Messrs. Mortimer, Shepherd and Co., a considerable effort is being made at Bournemouth with the view of introducing the electric light for public and private purposes. Among a large number of the inhabitants of this charming and healthy watering-place there has for some time past existed a desire to participate in the advantages accruing from a better system of lighting than that at present generally in vogue, and after practical proof of the efficacy of electricity had been afforded by the experimental illumination of the Arcade, which was carried out with thorough success, a public meeting took place, at which more than one speaker expressed a hope that a company might be formed. However, difficulties presented themselves, and the matter was allowed to remain in abeyance, so far as the public were concerned. But Mr. Shepherd, who had himself taken a prominent part in arranging the experiments and in explaining details of his electric lighting scheme, saw that there was a good prospect of doing business, and continued his exertions, one of the first fruits of which was manifested on the evening of Easter Monday by the electrical illumination of the pier by 15 arc lamps of 1,000 C.P. each, the necessary current being produced by an engine and dynamo at work on Messrs. Mortimer, Shepherd & Co.'s central premises in Orchard Street. During the evening the pier was thronged, the innovation being a powerful attraction both to the regular inhabitants and to many holiday-keepers who had made Bournemouth their rendezvous for the day.

After this system has been given a fair trial, Messrs. Mortimer, Shepherd & Co. intend working two others in succession, so that the Pier Commissioners may have an opportunity of choosing that which they think the best, should it be decided to adopt electricity permanently. During the experiments some special wires are to be made use of, which are said never to have been employed in England before. Several local business establishments have already undertaken to adopt electricity, and next week, on the occasion of an inaugural dinner, the "Belle Vue" Hotel will be lighted by this means.

## THE BRIGHTON ELECTRIC RAILWAY.

THE vexed question relating to Mr. Volk's electric railway at Brighton was once more before the Corporation at its meeting last week, a report being presented by the Work's Committee, submitting to the decision of the council a resolution which it had passed, calling upon Mr. Volk to remove his railway and its appliances from the Madeira Road, at six months' notice. During the discussion, Councillor HARKER moved the exception of the resolution in question, and inquired why the committee, if it was of opinion that the railway really constituted a nuisance, did not call upon Mr. Volk to remove it within one month, in accordance with the agreement which subsisted between them. If the railway did not constitute a nuisance, they were not justified in passing such a resolution. It was for the council to take into consideration the thousands of persons to whom the railway had proved an attraction and a convenience.

Alderman ABBEY contended that after the remarks which were made by Judge Martineau, during the hearing of the recent County Court action, the council could adopt no course other than that of ordering the railway to be removed, as by that means only could it escape future liability. Originally it was proposed to give Mr. Volk only one month's notice, but it was considered that if a longer period were granted, he would have a better opportunity of considering a proposal which was on foot for the transference of the railway from its present position to a more eligible site. If the negotiations with the Aquarium and Chain Pier authorities proved satisfactory, it was probable that Mr. Volk would run his railway under a covered way on the side wall; but, of course, that was a matter which would have to be sanctioned by the council.

Councillor HALL charged the committee with having failed to act fairly towards the council, and with making a piecemeal attempt first to dislodge Mr. Volk from his position and then to give him no satisfaction. At the committee meeting there were probably less than two-thirds present, and those who were there may have been totally opposed to the railway.

Councillor BLAKER contended, amid cries of dissent, that for the least accident that occurred on the railway, the Corporation would be liable.

Councillor BERRY ridiculed the idea of Mr. Volk being accorded compensation, when it was admitted that his receipts for three years had averaged £2,400.

Eventually, Alderman SENDALL (the mover of the report), said that he should withdraw his resolution, in order that the committee might bring up a report, which was what the council evidently desired.

After some opposition, the necessary permission was given.

## THE NATIONAL TELEPHONE COMPANY.

MANKIND are not very discriminating in their financial any more than in their other judgments. They have a bad habit of approving or disapproving in bulk. That has been conspicuously so with the industrial applications of electricity. One or two preliminary failures wore out the patience of investors, and threw the electric inventor on his beam ends before he had fairly got to work. Father Brush gave a bad name to his whole family, and threw back electric lighting for at least ten years. In a milder way telephony has in this country been discredited by the pioneers of the art. The parent institution—the United Telephone Company—has in its own sphere been, not, as might have been expected, the most successful, but the least successful venture of its class. It has not a single child in the provinces, even of a year or two old, which has not produced relatively better results from its own working. The United must always be a great and valuable property because of the large interest it has retained in its provincial offspring; but if had to live, as they have, on its own *bonâ fide* earnings, it would have to sup pretty often with Duke Humphrey.

This circumstance is rather annoying, not only to the shareholders of the United Company itself, but to those of the affiliated companies. The latter are kept under a cloud through the inefficiency and unpopularity of the parent institution. Its slow progress, and the small use it makes of its unequalled opportunities, cast a slur on telephone securities generally. The United being the best known on the market, all the rest are judged by it, and, as it so happens, they are harshly judged. Even the

National Telephone and the Lancashire and Cheshire, both of which own more extensive and better-paying systems than the United, are seldom mentioned on the London Stock Exchange. In the telegraph and telephone market there are perhaps not three jobbers who would undertake to make a price in them. But go to Manchester or Glasgow or Edinburgh, and you will find these stocks regularly dealt in. They are familiar to every broker, and seldom a day passes without a considerable amount of business in them. It is these companies which pay the bulk of the United Telephone dividends, and yet their own shares cannot command anything like the price of the Unitеds, which to a large extent are only Nationals and Lancashire and Cheshires under another name. This may sound strange and paradoxical to the reader, but a few figures will make it clear enough.

In the year ended June 30th, 1886, the United Telephone Company paid in dividends about £58,000 and placed to reserve £10,000. Of this £68,000 there was earned in the metropoiitan district—that is, by the United Telephone Company itself—£27,000, and in the provinces—that is by the provincial companies—£40,000. They pay tribute to the parent company in two different ways—first, royalties on the use of their instruments, which last year amounted to £35,301; and, second, dividends on their shares held by the United, £11,256, together £46,557. After charging this provincial account with one-half of the rent of the head office, one-half of the directors' fees, one-half of the auditors' fees and a few thousands more for salaries and wages, the United pockets a clear profit, as already shown, of fully £40,000 a year from the subsidiary companies. Two-thirds of its dividend money comes up to it from the country. Like Saturn, it lives on its children, and though it does not actually eat them, it bleeds them. We have pointed out more than once that the United Telephone Company is rather a telephone trust than a working company, and it might be well advised if it resolved itself into a trust pure and simple. It might farm its monopoly of the metropolis in the same way as it farms the provinces—namely, by forming a working organisation and ensuring control by retaining a majority of the shares. It would then have a steady revenue from royalties on instruments and from dividends on its portion of the working company's capital.

That policy has been attended with signal success in the provinces, especially in the Northern Counties and Scotland. The provincial companies have popularised telephony in all the districts they occupy. They have overcome far greater difficulties than the United has ever had to contend with in London. They have built up more important systems than the metropolitan, introduced greater improvements, and given a much larger development to the art. In long-distance telephony they have made great strides, while London has been standing almost still. But in the eyes of investors their chief virtue will be that they have shown a much more elastic earning power. The National Telephone Company especially has developed a marvellous faculty of producing dividends.

Only five years ago it started from nothing, and it now yields between thirty and forty thousand a year to its shareholders. In its infancy it earned only interest on its debentures, and 6 per cent. on a small issue of preferred shares (£150,000). In the December half of 1883 it paid its maiden dividend on the ordinary shares (£450,000). It was homœopathic—only one per cent. per annum, but a good omen. The next half-yearly distribution was at the rate of one and a half per cent., and ever since there has been an increase of one-half per cent. every time. The dividend has now reached four per cent. for the past half-year, and but for reductions of tariff, which had to be made in Glasgow, another half might have been paid. It is a moral certainty for the current half-year, and in twelve months from now National Telephone ordinary will be a five per cent. share, with a still more prosperous future.

The National Company appends to each of its reports a tabular statement of its gross revenue, working expenses, net income and dividend payments, which is a remarkable record of progress. It shows that between the year ended June 30, 1882, and the year ended June 30, 1886, the gross revenue increased from £26,996 to £80,674, or fully threefold; the royalties and working expenses from about £16,000 to £49,000; the debenture interest and preference dividends from £4,727 to £14,377; and the balance available for dividends from £144 9s. 8d. to £17,572 15s. 3d. The dividend payments on ordinary shares have been as follows:—

| | Rate per cent. | Amount. |
|---|---|---|
| December, 1883 | 1 | £2,250 |
| June, 1884 | 1½ | 3,375 |
| December, 1884 | 2 | 4,500 |
| June, 1885 | 2½ | 5,635 |
| December, 1885 | 3 | 6,150 |
| June, 1886 | 3½ | 7,875 |
| December, 1886 | 4 | 9,000 |

In the last completed half-year nearly twice as much was paid on ordinary capital as in the whole of the first dividend year, though in the meanwhile the preference charges had also been nearly doubled by the issue of £150,000 of second preferred shares, on which £4 has been called. The most eloquent proof of progress, however, is to be seen in the net revenue after payment of working expenses and royalties. That was, in the two years—first and last:—

| | |
|---|---|
| June, 1882 | £4,872 |
| June, 1886 | 30,969 |
| Increase (over 500 per cent.) | £26,097 |

In gross income the National already runs the United very close, both being about £80,000 a year. The exact figures, as given in the respective reports, are £81,530 for the United and £80,674 for the National. In extent of business, the National is decidedly ahead, and may claim to be the largest telephone system in the country. In December last it owned 7,157 subscribers' lines, of which 6,092 were Exchange, 1,065 private and 359 trunk. The trunk lines are formed in groups, which begin at Birmingham and extend to Glasgow and Dundee. There are a dozen groups centreing at Birmingham, Wolverhampton, Nottingham, Dewsbury, Halifax, Leeds, Bradford, Huddersfield, Workington, Whitehaven, Dundee, and Glasgow. It has taken a long while to bring them into satisfactory working, and hitherto most of them have been a drain on the company, but the initial difficulties are now all overcome, and the trunk lines are gradually becoming sources of profit. In provincial companies they have naturally a very important future, as, when fully developed, they must yield much better returns than short distance urban wires.

In a word, the National Telephone Company is an important and a growing property. It is managed by energetic men who have applied stout hearts and quick brains to the practical study of telephony. The chairman, Colonel Raynsford Jackson, is now generally recognised as one of the ablest telephone administrators in the country, and he has been much more fortunate than his friends in London in keeping on good terms with his six thousand and odd subscribers. The securities of the company deserve a wider market than they now enjoy, and London jobbers are short-sighted in leaving them altogether to Manchester and Glasgow. The ordinary shares, £5 paid, are now selling about 80s.; the First Preferred Six per Cents., £10 paid, about £13; and the Second Preferred, with £4 paid at 1 premium; and there is ample room for a substantial advance in all of them.—*Financial News.*

## ON THE DETERMINATION OF THE COEFFICIENT OF SELF-INDUCTION.

IN order to measure the coefficient of self-induction of a bobbin without iron and having but few turns of wire, say MM. Ledeboer and G. Maneuvrier in *Comptes Rendus*, we make use of the following method:—

The resistance bobbin, R, the self-induction coefficient, L, of which is sought, is arranged in electric equilibrium in a Wheatstone bridge used in the form of a graduated wire bridge. The slide having been brought to the middle of the divided wire, the equilibrium is made by means of a nickel-silver wire, forming the fourth branch of the bridge. A revolving interrupter introduced into the circuit of the battery and into that of the galvanometer, transmits at each rotation the extra current of rupture into the galvanometer. We obtain thus a permanent deviation. We then eliminate the constant of the galvanometer and the intensity of the current which passes into the bobbin by making a second experiment. We stop the interrupter and we displace the slide by a small distance, $\epsilon$; this destroys the equilibrium of the bridge and occasions in the galvanometer the passage of a feeble current which produces a deviation, $a$. We then find the coefficient of self-induction, L, by introducing these values of $\delta$ and $a$ into the formula

$$L = R \frac{2\epsilon}{l} \frac{1}{n} \frac{\delta}{a}$$

$l$ being the length of the divided wire which corresponds to the resistance, R, and $n$ the number of turns per second of the revolving interrupter.

We have verified the accuracy of this method by comparing the results which it gives for the coefficient of self-induction of any two different bobbins with the results yielded by the direct measurement of the extra current. The following are the numbers given:—

| | Above method. | Direct method |
|---|---|---|
| 1st bobbin R = 0·122 ohm. | L = 0·00101 | 0·00102 ($\times 10^9$ cm.) |
| 2nd bobbin R = 0·431 ohm. | L = 0·00142 | 0·00143. |

We have found, besides, that on substituting a straight wire for the bobbin, no appreciable deviation is produced on turning the interrupter.

We have applied this method to the measurement of the coefficients of self-induction of a Siemens electrodynamometer and we have found the following values:—

| | R. ohms. | L $10^9$ cm. | $\frac{L}{R}$ |
|---|---|---|---|
| Thick wire (entire apparatus) ... | 0·010 | 0·0000035 | 0·00035 |
| „ „ (fixed coil alone) ... | 0·0060 | 0·0000023 | 0·00038 |
| „ „ (movable coil alone) ... | 0·0040 | 0·0000012 | 0·00031 |
| „ „ (entire apparatus) ... | 0·431 | 0·00142 | 0·0032 |

The movable coil of the apparatus has only four turns of wire; the fixed coil has seven turns of thick wire.

These numbers are available for the verification of the following fact. In the Siemens electro-dynamometer, the movable bobbin has its axis perpendicular to that of the fixed bobbin, and the current traverses the two bobbins in series. Hence it results that the mutual induction between these two bobbins is nul, and that the coefficient of self-induction of the entire apparatus should be the sum of the coefficients of self-induction of the two parts.

This is, in fact, verified by the numbers just obtained. In particular (as happens approximately in this case) when the ratios $\frac{L}{R}$ are equal for the two bobbins, separately, calculation shows that we must have the same value of the ratio for the entire apparatus. Now this ratio, $\frac{L}{R}$, has here the value of 0·00038 for the fixed frame, 0·00031 for the movable frame, and 0·00035 for the entire apparatus.

We know that this relation intervenes in the case of the measures relating to alternating currents, and it is with the view of studying these currents that we have undertaken these preliminary experiments.

As will be seen, our method consists in a novel adaptation of the known methods of Maxwell and of Lord Rayleigh to the particular case where the current is too feeble to give an appreciable impulse to the galvanometer. It presents the further advantage of rendering the use of a ballistic galvanometer unnecessary, and of rendering the employment of an ordinary mirror-galvanometer possible and practicable. We prefer it to the other methods of measuring weak coefficients of self-induction, and especially to the method of M. H. F. Weber (a modification of that of Mr. Hughes), because it leads to a very simple formula and because it requires, except the Wheatstone bridge, no other experimental appliance than a rotary interrupter.

## NOTES.

**The Electric Lighting at Glossop.**—With reference to the controversy upon this subject we have received the following communication from Messrs. Sanderson and Ruddle, of Manchester:—"Referring to the note in the last issue of the REVIEW, *re* the lighting of a mill in Hadfield, personally we are not connected with the installation, but in the interests of electric lighting in general could not allow the original misstatement to pass unchallenged, that an outlay of £3,500 was necessary for electrical plant to simply take the place of gas costing but £191 per annum. The gas company (which has evidently been deprived of a good customer) gave the gas bill for the year 1885, but omitted the fact that the mill has since been so enlarged, that the difference in price between the two illuminants is such, that the firm decided to adopt the more economical one, and the actual results obtained verifying their expectations they have arranged for its adoption in another mill. As for the figures we gave, we challenge the gas company to disprove them."

**Proposed Electric Lighting at Winchester.**—The inhabitants of the fine old cathedral city of Hampshire have become heartily disgusted with the oil lamp system by which their streets are at present lighted, and the question was brought before the notice of the Town Council last week, when the report of a special committee showed that the cost of the 393 oil lamps in use was £884 per annum. As these had, however, long ceased to satisfy the public, the committee recommended the adoption of a system of partial lighting by electricity on the Thomson-Houston system, now in use at Taunton, to be used only in the chief streets. Two schemes were propounded, one involving an extra rate of 2d. in the £, and the other one of 4d. in the £. Mr. Godwin moved that the first scheme should be adopted, and, in seconding, Mr. Kirby pointed out that the system had been worked most successfully at Taunton, and was becoming quite popular. Mr. Warren opposed the proposal *in toto*, as the inhabitants of those streets which were not lighted by electricity would still be obliged to contribute to the special rate. He contended that the electrical system had proved costly and ineffective in many parts of the country. Other speakers followed, it being generally admitted that the present lighting of the town was extremely defective and required alteration, but there being some differences of opinion as to the best mode in which an improvement could be effected. Eventually the matter was adjourned for a month, in order that the members of the council might have a full opportunity of considering the matter.

**Electric Lighting in Glasgow.**—At a recent meeting of the committee on the New Municipal Buildings it was reported that, at a joint meeting of the sub-committees appointed by this committee and the Bazaar Committee on February 19th and April 6th, respectively, on the subject of the electric lighting of the New Municipal Buildings, the New Bazaar, and the City Hall, they had instructed that plans and tenders for supplying and fitting up the necessary engines, dynamos, wires, &c. (but exclusive of electroliers, pendants, and brackets,) for lighting the Bazaar, City Hall, and a portion of the New Municipal Buildings, be invited by advertisement from competent parties, who should be referred for further information to Mr. Carrick as regards the Bazaar and City Hall buildings, and to Mr. Young, architect, as regards the Municipal Buildings. The report was approved, and the Town-Clerk was instructed to prepare and advertise the necessary notice.

**Theatre Illumination.**—The 100th night of "Monte Cristo," now being played at the Gaiety Theatre, was celebrated by a supper and dance on Sunday night last, on which occasion electric light played a very important part, there being 250 lights on the stage. The foot-lights were very tastefully decorated with ferns, palms, and fresh cut flowers, in the centre of which was a large cut glass bowl, in which were fixed five 16-C.P. lamps, with a coronet base laid on a cushion, representing a large diamond of Monte Cristo. A large canopy was fixed over the stage, in which were hung four large electroliers, and round the sides were fixed numerous lamps in variegated shades, the whole presenting a very pretty effect. The electric arrangements were carried out by E. L. Berry and Co., who have done their utmost to carry out the wishes of Mr. Charles Harris.

**Theatre Lighting.**—The Royal Theatre, of Berlin, the *Gas World* states, has been the scene of a sudden extinction of the electric light, followed by a kindling of the indispensable auxiliary gas burners. Precautions are to be taken to avoid a repetition of the mishap, so it is said; but it seems to be labour wasted to publish, for the information of the public, elaborate reports of the precise reasons why the mishap had occurred, as was done in the Berlin papers after the accident had happened.

**Electric Lighting at Hull.**—The fortnightly meeting of the Sub-Property Committee of the Hull Corporation was held on the 31st ult., when Mr. White, the borough engineer, read the following report:—The borough engineer, pursuant to the resolution of the 15th December, 1886, begs to report, with reference to a scheme of electric lighting for the Town Hall and the Market Hall and the shops therein, that he is of opinion that such a scheme could only be adopted by a largely-increased outlay over that involved in the use of gas, seeing that the only saving to compensate for the provision and working of an extensive plant would be the value of the gas requisite for lighting during a comparatively small number of hours each day. Should the corporation, however, be of opinion that the advantages of the electric light over gas are sufficient to counter-balance such increased outlay, he considers that the buildings might be most advantageously let for one station, which might also be made available for the production of light for other purposes, but the corporation do not seem to possess a suitable site for such a station, and it would therefore be necessary to rent or purchase a site for the purpose. As regards the method of lighting the respective buildings, it appears that the most efficient and economical manner of dealing with the large spaces is by arc lamps, and for this reason it is assumed that the Market Hall and the entrance hall and banqueting room of the Town Hall would be lit by means of such lamps, and that in other cases incandescent lamps would be used. In calculating the cost of the installation, provision is made for electric light in the Town Hall to the same extent as when it was previously in use, viz., to the extent of five 1,000-candle arc lamps and 120 incandescent lamps, and in the Market Hall provision is made for four 1,000-candle arc lamps, together with 300 incandescent lamps in the shops connected therewith. The borough engineer estimates the first cost of such an installation at £4,000, exclusive of site for station, and the annual expenditure, including 10 per cent. on the above amount for interest and depreciation, at £570, to which should be added the interest upon the value of site for station, say £25, making £595. The saving in gas alone by the adoption of the electric light to the extent indicated he estimates would not exceed £300 per annum. As to the production of lights for other purposes, he estimates the cost of duplicating the plant at £3,200, and the annual expenditure on account of the additional plant, including interest and depreciation, at £420. The Chairman said it appeared to him that in the present temper of the council they would not entertain the proposal. It was agreed that the report be printed and circulated, and considered at a future meeting of the sub-committee.

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**Electric Lighting in Paris.**—The electric light and power installation at the Hotel de Ville, *Industries* states, is being extended. There have been two 65 H.P. engines in use, driving dynamos which have served for lighting a portion of the building, and for the working of ventilating fans by means of motors. This generating plant is placed in the cellar of the building. Two more engines of the same power, and corresponding dynamos, are now being put down in the neighbouring Loban Barracks, and the current will be employed in lighting the great hall, which is being fitted with 16 electroliers of 72 lamps each, and some adjoining rooms, containing in all 50 electroliers of 18 to 24 lamps each. The wiring is arranged on the overlapping principle, so that each room is supplied from at least two different dynamos and engines, with a view to preventing total darkness in case of a breakdown. The contractor for the work is M. Chretien, who is well known in electrical circles as the author of a project for an elevated electric railway in Paris.

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**Electric Lighting in Spain.**—The Gülcher Company of Vienna is installing the electric light in the extensive printing establishment of the Madrid illustrated paper *La Illustracion*. There will, *Industries* states, be 206 glow lamps of 16 C.P.

**Electric Light Machinery a Nuisance.**—In the Rue St. Honoré, Paris, there is a large establishment called Arena Aéronautique, which is in part a public bath, and in part a circus for aquatic performance. The electric light has been fitted in this building on a magnificent scale, to the entire exclusion of gas; but the neighbours, *Industries* states, brought an action against the contractor, on the grounds that the electric light machinery created a nuisance in the district, and this action ended in an injuction to discontinue the electric light. The owner was, therefore, obliged to return to gas. This is the third legal proceeding of this nature against electric light contractors within the last few weeks.

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**Electrically Illuminated Cars.**—The Julien battery is in use on the Boston and Albany railway for lighting the cars. On one of the cars is a battery consisting of 60 cells, each measuring 6½ by 5½ inches, and 8 inches high, containing 19 plates and weighing in all 27 pounds. So thoroughly satisfied are the officials of the line with the working of the experiment that they have given orders for the immediate equipment of the entire trains which leave Boston for New York and New York for Boston at 4.30 p.m. daily. Other trains are to be equipped as rapidly as possible.

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**Electrical Train Lighting on the Glasgow Underground Railway.**—Mr. T. P. Carswell writes from Edinburgh regarding a paragraph in our last week's notes respecting the lighting of the Glasgow underground trains. He says:—"You seem to have been misinformed as to the C.P. of the lamps. When the first two trains were fitted, 100 volt 16-C.P. lamps were used, but only one in each compartment was lit at a time. In trains lately fitted, two 25 volt 10-C.P. lamps are used in the first class compartments, but both are lit at once, the third classes remaining as before. At first, clear globes were used, but latterly frosted ones have been put in the first classes, and this may account for the light not seeming so intense, although newspaper type can be easily read."

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**An Erratic Telephone.**—Evidently the management of the telephone is not much more perfect in some parts of Australia than it is in London. At a recent meeting of the Brisbane Chamber of Commerce, we learn from the *Colonies and India*, dissatisfaction was expressed at the working of the telephone system in that city. The chairman said they flew to the telephone when they were in a hurry, but very often the result was that they could not get a reply, and when they did they were very often switched on to the wrong person. Mr. A. J. Carter suggested that a hospital was required for the treatment of some of the instruments. Mr. Gill complained that boys were employed to do the work, who thought it fun to humbug the people. Mr. De Winton remarked that the Postmaster-General had to issue a circular forbidding the use of improper expressions through the instruments. The chairman added that he had a telephone at his house at Breakfast Creek, but he was only able to use it once a week. Yet he had been rung up in the middle of the night and asked, "When are you going to send the timber?" He could understand bad language under such circumstances. He did not say the officials should allow one man to abuse another. It would be better to let the men get together in such cases. Mr. T. Unack confessed he had been often tempted to use bad language at the telephone, but he found it better to have a padded corner near the instrument to relieve his feelings upon, and he recommended the idea to the meeting. A deputation was appointed to wait on the authorities.

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**The Government and the Telephone.**—It was resolved at the recent meeting of the Royal Convention of Burghs (Scotland) to urge upon the Government the desirability of acquiring all telephonic facilities and working the same as a branch of the postal service.

**Sea Telephony.**—Mr. Henry Edmunds says he has read with interest our account of Mr. Edison's experiments with his sea telephone, and proceeds :—"It may interest you to know that on February 12th, 1878, I took out a patent, No. 584, for an apparatus which I called the "Aquaphone," which essentially consisted of a submerged sounder, which could be actuated by means of a key operated either from a boat or on the shore. It was soon found that signals which were entirely inaudible in the air at a given range were distinctly audible under water, even at twice or three times the extreme limit of their range in air. After trying several kinds of receivers, the simplest was found to be a pine rod, with one end shaped like a paddle, immersed about three feet in the water, with the other end held close to the ear. Experiments were made in February, 1878, down below Greenwich, where an attendant in a boat (which was several times hidden from sight by intervening objects) received and transmitted signals readily, and acted in accordance with a pre-arranged code. The matter was then brought to the notice of the Trinity House, and of Sir James Douglass, that the experiments might be carried out on a larger scale, but he said that they had no funds at their disposal for that purpose, and could only consider the thing in its completed form. Again in 1879, off the Lancashire Coast at Blackpool, I made fresh experiments in a very rough sea, and had no difficulty in making and receiving signals, provided the sounder and the receiver were sunk sufficiently deep below the surface of the waves. Want of time and opportunity prevented further experiments in this interesting field, and therefore the matter has been in abeyance. I think, however, that a simple form of "Aquaphone" could be attached to all vessels, and worked either electrically or mechanically. This would have several advantages for signalling purposes. It would not be interfered with by fog or external noises, nor by the nuisance that most fog signals are at present to landsmen within hearing of them."

**Telephonic Extension in the West.**—We have before spoken of the enterprise shown by the Western Counties and South Wales Telephone Company, under the management of Mr. H. F. Lewis, and we are pleased now to learn that it is possible to converse clearly and distinctly between Bristol and Cardiff, through 66½ miles of wire, the line running *via* Sharpness, the Severn Bridge, Lydney, and Newport. The company has been actively engaged during the past 12 months in forming the trunk lines which are to connect the various towns in the West of England and South Wales, and have already completed and got in working order 127 miles of communication, which, with the multiplication of wires, represent 398 miles of wire, the following being the places which have thus been brought within speaking distance of each other :—Cardiff and Newport, 14 miles; Bournemouth and Poole, six miles; Bristol and Bath, 13½ miles; Bristol and Cardiff, *via* Sharpness, Lydney, and Newport, 66½ miles; Cardiff and Pontypridd, 12 miles; Swansea and Llanelly, 12 miles; Torquay and Paignton, three miles. The following trunk lines are in course of erection, and will, it is expected, be completed early in May :—Bristol and Gloucester, 39 miles; Cardiff and Swansea, 50 miles; Swansea, Landore, Morriston, Neath, and Briton Ferry, 17 miles; Pontypridd, Aberdare, and Merthyr, 18 miles. The company further intends as soon as it receives sufficient support, to connect Bristol with Weston-super-Mare, Newport with Pontypool, Plymouth with Exeter and Torquay, Portsmouth with Bournemouth, Gosport, and Southampton, Torquay with Newton Abbot, Weymouth with Dorchester, and Worcester with Malvern, and eventually it is contemplated to connect the whole of the towns of the West of England and South Wales through a central station at Salisbury with the metropolis.

**Telephonic Extension in Scotland.**—Last week telephonic communication was established for the first time between Glasgow and Dunfermline.

**The National Telephone Company.**—On another page we print an article respecting this company which appeared in the *Financial News* of Wednesday. Thursday's issue of our contemporary contained this announcement :—"National Telephone shares were yesterday the general subject of talk in the telegraph market. The few jobbers who had any put up their price ¼ right away, and those who had none telegraphed to Manchester and Liverpool for them. A good deal of business was done in them, and they promise to become a favourite line."

**Generous Telegraphists.**—The officials and *employés* belonging to the German Post and Telegraph Offices recently collected amongst themselves the sum of 17,000 marks for the purchase of three lifeboats, to be placed at the disposal of the German Society for the Rescue of Shipwrecked Mariners, and the gift has just been acknowledged by a cordial letter of thanks from the Emperor.

**Continental Telegrams.**—At the annual meeting of the Royal Convention of Burghs, held in Edinburgh last week, a motion to memorialise the Government as to the desirability of reducing the telegraph rates to and from the Continent, and the rates of postage to the colonies and all British possessions, was passed.

**Paris-Brussels Telephone.**—The average number of communications over this line, according to *Industries*, is from eighteen to twenty-three per hour, and, in consequence, arrangements are being made for a second bronze wire between the two capitals. A still larger number of communications will take place when the subscribers to the telephone systems are connected, and enabled to speak direct from their own offices. Recent experiments show this to be possible, although the loss in the volume of speech, due to the employment of the subscribers' lines and instruments at Brussels, will be 50 per cent. Negotiations are in progress for the establishment of telephonic communication between Brussels and Amsterdam.

**A New Motor.**—Local papers in the Widnes district are waxing enthusiastic regarding an invention of Mr. James Hargreaves, who claims that with a consumption of two gallons of common coal tar per hour he can obtain a motive power equal to 30 horses. The cost of running is estimated to be at the rate of 1d. per hour for 20 horse-power; this with an old engine which has been the subject of trying experiments, so that an even better result is anticipated when a new engine is constructed possessing all the improvements suggested by experience with the old one. Shale oil, crude petroleum, or the waste remaining after refining petroleum, are said to be equally available with coal tar. All the heat developed by the combustion of the fuel is intercepted and made to do work instead of being allowed to escape up the chimney; this is done so effectually that the hand can be held in the exhaust pipe without injury, although the exhaust contains all the products of combustion.

**Demagnetising Watches.**—"P. E. R." writes :—"In the current issue of your journal I notice a correspondent gives some valuable advice with respect to demagnetising a watch that has become magnetised. Now I feel sure there are others besides myself who would be glad to know how a watch may be rendered non-magnetic without being specially built so. I shall shortly have occasion to use a high class chronograph in conjunction with some electrical apparatus, and feel pretty sure that before long the watch will become magnetised. The question is, how to prevent it? It is not necessary that any device that will effect the object in view, should be sufficiently portable to be always carried with the watch, as the watch will have to be fixed in a given position for use, and plenty of scope is available for protecting it, if such is possible. The only *sine qua non* is that the face must be visible."

**A Method of Charging Secondary Batteries, &c.**—Mr. J. W. Giltay writes from Delft:—"Under this somewhat long title, Mr. F. T. Smith, in your issue of April 8th, says:—'The idea of putting the current on to one cell at a time seems to be due to Poggendorff (if I remember right), *Electr. Magazine* for 1842.' Allow me to tell Mr. Smith that he does not remember right. The 'polarisation-battery' he seems to have in view was invented by T. Thomsen, of Copenhagen, in the year 1864, and has been used in Denmark, as was the intention of the inventor, for telegraphic purposes. His description can be found in *Poggendorff's Annalen*, 1865. In a later number of the same periodical Poggendorff asserts himself to be the inventor of this battery, which assertion is afterwards refuted by Thomsen. Poggendorff, by means of his 'Wippe,' charges the whole battery at once in parallel, and discharges in series, and therefore only gets intermittent currents, while Thomsen, on the contrary, by charging only one cell at once gets a continuous (although somewhat undulating) discharging current."

**On Varnishing Incandescent Lamps.**—A contributor to a contemporary last week drew attention to a method of varnishing incandescent lamp bulbs so as to give them the appearance of ground glass. The process described appears identical with that devised by Mr. Augustus Littleton, of Sydenham, more than two years ago, and for which he obtained provisional protection in the Patent Office. Of the simplicity of Mr. Littleton's process we can speak in terms of the highest praise, and the effects produced are charming. The following extract from the provisional specification will be found serviceable:—"I make up a solution of the following ingredients: gum mastic, 22 parts; gum sandarac, 4 parts; ether, 200 parts; benzole, 75 parts, and in this solution I immerse the incandescent electric lamp or the object upon which it is desired to produce the aforesaid effect." The solution rapidly dries, and the thickness of the deposit may be varied by altering the component parts of the solution or by immersing the object a second or third time. Lamps subjected to this process are in constant use in Mr. Littleton's house; the cost of production is very small, and hundreds of bulbs may be prepared by one individual in an hour. The patent was applied for on April 21st, 1885, and entitled, "A method of subduing or modifying light more particularly applicable to incandescent electric lamps."

**Electric Heaters.**—Dr. Tommasi having claimed to be the originator of the idea of "applying the heat developed in an electric circuit of high resistance to the warming of railway cars," Mr. W. Leigh Burton, of Richmond, Va., writes to say that in the patent issued to him on March 23rd, 1869, for "An improvement in electric heating," a drawing is attached showing how the device might be applied "for the warming of railway cars." A model of his electric heater was taken to France in 1870 or 1871, by M. C. F. Pardigon, who proposed to lay the invention before the faculty of the College de France, but was prevented from doing so by the outbreak of hostilities between France and Prussia. Mr. Burton has obtained a new patent for an important improvement in his electric heater, and thinks he has good grounds for hoping that in the near future the utilisation of electric heat for the warming of railway cars will be *un fait accompli*.

**Storage Batteries in America.**—The storage battery business, says the New York *Electrical Review*, is looking up. The Electrical Accumulator Company, of this city, owning the patents of Camille Faure and others, has commenced suit against the Julien Company and against the Brush Company for infringement. The two most active companies working in this field are the Electrical and the Julien, yet the Brush Company has experimented largely in the past, and owns several early patents covering the work of Mr. Brush.

**Electrical Distribution.**—We are indebted to Prof. Elihu Thompson for a corrected copy of his remarks in the discussion which took place at last month's meeting of the American Institute of Electrical Engineers, when the President, Mr. F. L. Pope, opened the proceedings with a discourse on electrical distribution by means of secondary generators. The report of the meeting, which we reproduce from the *Electrical World*, is of an extremely interesting character.

**Specifications Issued.**—Improvements in dynamo-electric machines, No. 4,884, 7th April, 1886, John Platt, John Hopkinson, and Edward Hopkinson; Improvements in telephone transmitters, No. 5,824, 29th April, 1886, John Lorimer Corbett; Improvements in telephonic apparatus, No. 5,825, 29th April, 1886, John Lorimer Corbett; Improvements in and relating to incandescent electric lamps, No. 5,962, 3rd May, 1886, Thomas John Handford; Improvements in or connected with electrical batteries and appliances therefor, No. 5,971, 3rd May, 1886, Alfred William Armstrong; Improvements in the preparation of carbon filaments for electric lamps, No. 6,203, 7th May, 1886, Herbert John Haddan; Improvements in metallic telegraph poles, and poles and posts for various purposes, No. 6,866, 21st May, 1886, John Clarke Johnson; Improvements in the manufacture of carbon electrodes, No. 9,518, 22nd July, Robert Applegarth; Improvements in dynamo-electric machines, No. 9,582, 24th July, 1886, Joseph Platt Hall; Improvements in the construction of electrical storage batteries, No. 10,502, 16th August, 1886, Edward Frankland; Improvements in the process of and apparatus for manufacturing carbons for electric lamps, No. 10,800, 24th August, 1886, John Thomas Lister; Improvements in primary batteries, No. 13,592, 23rd October, 1886, Mark Bailey and John Warner; An improved method of preventing the escape of noxious fumes from batteries used for electrical purposes, No. 14,937, 17th November, 1886, Mark Bailey; Improvements in the construction of tubular receivers or pipes for the reception of underground telegraph lines and the like, No. 213, 6th January, 1887, John Aird; Autographic telegraph, No. 1,527, 1st February, 1887, Herbert John Allison; Improvements in circuit closing apparatus for electric brake and other circuits, No. 1,570, 1st February, 1887, Elias Elkan Reis; Improvements in electric signals for engines, No. 1,584, 1st February, 1887, James Clarke Ricketson; Improved apparatus for preventing the escape of noxious fumes or other gases from primary, secondary, gas, or other batteries used for electrical purposes, No. 1,656, 2nd February, 1887, Mark Bailey and John Warner; Improvements relating to electric batteries, No. 1,752, 3rd February, 1887, Henry Harris Lake.

**A Phonographic Relic of Beecher.**—There is a story in the newspapers which states that Mr. Edison, the electrician, has preserved a remarkable memento of the late Henry Ward Beecher. The inventor's phonograph for impressing on a soft metal sheet the utterances of the human voice and then emitting it again by the turning of a crank has never been put to any valuable use, and Edison has only gained from it a few thousand dollars in royalties from exhibitors. But he utilised it to make a collection of famous voices. Since he became famous his visitors have included hundreds of celebrities. Instead of asking them for their autographs or photographs, he has, in two or three hundred instances, requested them to speak a few sentences into a phonograph.

**Past and Present Telegraphy.**—At the sixth meeting of the Association of the Birmingham students of the Institution of Civil Engineers, a paper was read by Mr. E. Dodd, Stud. Inst. C.E., upon "The Past and Present Telegraphy," in which the author gave an outline of the history of the first telegraph line constructed in England, and also described the various improvements made in batteries, wires, insulators, poles and other instruments.

**Professor Tyndall's Retirement.**—In retiring from the Chair of Natural Philosophy at the Royal Institution, Prof. Tyndall has refused anything in the nature of a retiring allowance. He is to be made an Honorary Professor of the Institution, and a course of lectures bearing his name is to be established. His bust in marble will be subscribed for by the members, and it will be placed in near association with the statue of his friend Faraday. Prof. Tyndall is understood to be in comfortable circumstances, and his health shows signs of improvement. The successor of Prof. Tyndall has not yet been appointed, but Lord Rayleigh has been nominated.

**New Book.**—Mr. Paul Bedford Elwell will publish shortly, with Messrs. Whittaker & Co., an English translation of Gaston Plantè's work on "The Storage of Electrical Energy."

**Dynamo-Electric Machinery.**—At a recent meeting of the Stafford Road Junior Engineering Society, Wolverhampton, a paper was read by Mr. E. Yates on "Dynamo-Electric Machinery." Through the kindness of Messrs. Elwell, Parker and Co., who supplied storage batteries, the room was efficiently lighted by the electric light. A number of dynamos and motors of various designs, together with a plentiful supply of electrical apparatus, were exhibited at work.

**Electric Material for the Austrian Army.**—Orders for field telegraph material and movable electric light apparatus were given out by the Vienna War Office last week for prompt delivery.

**Electric Lighting in Galveston.**—The Brush Electric Lighting Company, of Galveston, is doing a good business, the *Electrical World* states. It furnishes fifty 2,000 C.P. arcs for the city, and 125 for private parties, in addition to about 275 incandescents. There are four 65 light, two 28 and one 10 dynamos in use, with two 16 × 32 150-H.P. Buckeye engines, and three 125 H.P. steel boilers made by Smith and Techont, of Cleveland. They run low-pressure condensers with the engines. The lot is 180 × 120, and the building covers 130 × 110 feet, so that there is elbow room. The 12 o'clock light rate is 65 cents; the all-night, $1; and the 10 o'clock, 50 cents. Coal costs $6.25 a ton in Galveston. The company supplies about 130 H.P. of power during the day. The Brush motor is in use here. Mr. W. S. Hipp is the superintendent.

**Electric Lighting in Brussels.**—The electric light has been supplied, *Industries* states, to the works of M. Boël, in Brussels, where over 2,000 men are employed; 10 arc lamps of 16 ampères, 12 of 12 ampères, and 125 glow lamps of 16 C.P. are used. The current is supplied by a Gerard slow-speed dynamo. M. Dulait, of Charleroi, has lighted the Sacré Madame Colliery, employing a modification of the Brush dynamo, which supplies eight arc lamps and 150 Khotinsky glow lamps. The engineers of the telegraph department are at present engaged in considering the electric lighting of all the Government offices of Brussels by means of 6,000 to 7,000 glow lamps. The Schaerbeek railway station is to have its installation increased by three arcs, to be placed at the busiest part of this junction. The last Congo State gazette contains the announcement of a patent granted to M. E. Julien for secondary batteries, this being the first patent taken out for the Congo.

**Electricity and Mining.**—According to an American paper which has been sent up, one of the most important improvements in the methods of treating gold and silver ores has recently been tested at the Douglass mill in Dayton, Nev. The inventor is Dr. J. H. Rae, a mining engineer. The principle involved is the utilisation of the electrical current of a dynamo applied to the amalgamating pans. The *Mining and Scientific Press* of San Francisco is reported as saying:—"The success of the experiments with the electric system of preventing flowing of mercury and loss of amalgam, to which we have referred several times of late, is a general topic of conversation among quartz and tailing mill-men. The experiment demonstrated that the saving in quicksilver alone equals about $500 per month to each amalgamating pan besides increasing the bullion contained in the amalgam 50 per cent., making it possible to convert low grade tailings into bullion at a profit, which by the old method was impracticable."

**Telephonic Experiments.**—A curious incident is said to have occurred at the telephonic station in the Place de la Bourse, at Paris. The clerk in charge of the instruments there was warned by the telephonic clerk in Brussels that a procession was about to pass, and that he would place a microphone which was close to the open window in connection with the telephonic line. This was done, and it is affirmed that the clerk in Paris heard distinctly the music played by the band which headed the procession passing in front of the telephonic station in Brussels.

**West African Cable.**—The repair of the West African Telegraph Company's cable has been successfully accomplished, and messages from St. Paul de Loanda can now be forwarded as usual. The rate is 8s. 11d. per word.

## NEW COMPANIES REGISTERED.

**Dixon and Corbitt and R. S. Newall and Company, Limited.**—Capital £120,000 in £10 shares. Objects:—To take over the partnership businesses of Dixon and Corbitt and R. S. Newall and Co., of the Teams, Gateshead, and to manufacture hemp and wire rope, telephone, telegraphic, and electric light cables, lightning conductors and electrical appliances. Signatories (with one share each) *G. Dixon, *J. Corbitt, M. Corbitt, Gateshead; R. Dixon, Newcastle; *C. Leddell, C.E., 24, Abingdon Street, S.W.; *J. G. Gordon, Lindore, Glamorgan; J. Simpson, Heworth, Durham. Director's qualification 300 shares; remuneration £100 per annum each. Registered 6th inst. by Horne and Birkett, 4, Lincoln's Inn Fields.

**Hermite British Electro Bleaching Company, Limited.**—Capital £50,000 in 1,500 A shares of £30 and 1,000 B shares of £5 each. Objects:—To purchase the patent rights of Eugene Hermite (electrical engineer); E. J. Paterson and C. F. Cooper, of Pownall Road, Dalston, for improvements in bleaching, and for apparatus for the preparation of bleaching solutions by means of electrolysis. Signatories (with one B share each) C. Roath, 14, Southampton Street, Bloomsbury; *R. Pinkney, 18, Bread Street Hill; *J. Hill, The Elms, Clapham; S. Gillett, 18, Brondesbury Road, N.W.; S. Coote, 42, New Broad Street; W. H. Heaton, Nottingham; *F. Hovenden, Glenlea, West Dulwich; G. W. Miller, 132, New Kent Road. Directing qualification, 8 A or 24 B shares. The company in general meeting will appoint remuneration. Messrs. E. Hermite and E. J. Paterson are appointed directors, the former to be technical director at a salary of £500 per annum. Registered 7th inst by Routh, Stacey and Co., 14, Southampton Street, Bloomsbury.

## OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

**The London Battery Company, Limited.** — An agreement of 31st ult. (filed on the 4th inst.) provides for the purchase by this company of the business carried on at 83A, Farringdon Street, by Mr. A. W. Armstrong under the style of the London Battery Company. The purchase consideration is £5,300, payable £300 in cash

* Signatories whose names are preceded by an asterisk are also directors.

and £5,000 in ordinary shares. The vendor is appointed manager for five years at a salary of £150 per annum, and will also be entitled to 2½ per cent. upon the certified net profits.

**Maxim-Weston Electric Company, Limited.**—The annual return of this company made up to the 18th ult. was filed on the 7th inst. The nominal capital is £125,000, divided into 500,000 shares of 5s. 306,000 shares are allotted and the full amount has been called thereon. 72,500 shares are considered as fully paid, and £58,375 has been received in respect of calls upon the remaining shares.

## CITY NOTES.

### The Indo-European Telegraph Company, Limited.

THE directors' report for 1886 states that the company's revenue from all sources amounted to £104,583 0s. 7d., as compared with £115,150 3s. 1d., showing a decrease of £11,567 2s. 6d.

The expenses were:—On commercial and general account, £27,307 2s.; on maintenance account, £23,466 5s. 8d., including £242 8s. 9d. paid to the Russian Government; total £50,773 7s. 8d., as against £51,597 8s. 11d., a decrease of £824 1s. 3d.

Deducting the above expenses, taking credit for £1,456 5s. 1d. balance brought over from 1885, and debiting income tax, there remains the sum of £53,593 6s. 7d. From this amount £10,000 has been placed to reserve, and that sum, together with £10,625 amount of interim dividend, have to be deducted, leaving a balance of £32,968 6s. 7d.

The directors now propose the declaration of a dividend for the last six months of 17s. 6d. per share, making, with the interim dividend already paid, 6 per cent. for the year, and a bonus of 20s. per share, both free of income tax, making in all 10 per cent. for the year, carrying forward £1,093 6s. 7d. to the credit of 1887.

The directors have purchased the chief interest in the company's lease of its central offices for the sum of £10,362 at 4½ per cent. and have paid for the same out of the reserve fund.

The two special circuits secured from London to Teheran, by arrangement previously reported, work very satisfactorily, and the company's system generally continues in excellent order.

The diminution of revenue as compared with 1885 is largely owing to the traffic of that year having been considerably increased by exceptional causes, fully explained in last year's report. There is, however, an actual falling off in the number of words transmitted, notwithstanding the reduction of the tariff introduced from the 1st of July last, so that in addition to the loss per word occasioned by the reduced rate, the business itself has decreased. This decrease is still going on, but the directors hope that looking at the revival of trade now becoming apparent, a rebound may take place.

As frequently reported to the shareholders, the company's system is capable of dealing with many times the number of messages that can be hoped for from the Indian and Trans-Indian business. The company, after prolonged negotiations with the Russian Government, has succeeded in obtaining the privilege of utilising some of the idle time of the wires by carrying certain South Russian correspondence. The tariff received for the work performed is very small, but will contribute to the general revenues. The arrangement took effect from January of the current year.

### TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the weeks ending April 1st and 8th respectively were £3,353 and £2,324.

The West Coast of America Telegraph Company, Limited. The gross earnings for the month ending March 31st were £4,875.

## NEW PATENTS—1887.

4744. "Means for supporting or suspending elements in electric batteries." H. I. HARRIS. Dated March 30.

4781. "Electrical batteries." ELECTRICAL POWER STORAGE COMPANY, H. W. BUTLER. Dated March 30.

4795. "Direct motor wheel for driving dynamos, &c., with peculiar adjustment for the application of motive power." F. F. LEE. Dated March 31.

4809. "Insulating electrical conductors." E. TORTORA. Dated March 31.

4823. "Galvanic battery." C. H. CATHCART. Dated March 31.

4824. "Generating electro-magnetic currents." O. C. D. ROSS. Dated March 31.

4830. "Duplexing needle telegraphs; other telegraphic or electric purposes." J. FLEMING. Dated March 31.

4832. "Carbon plates or electrodes for use in primary batteries and for electro-metallurgical, electrolytical, and other electrical purposes." H. LIEPMANN. Dated March 31.

4866. "Electric incandescent or glow lamps." T. V. HUGHES. Dated April 1.

4914. "Switches for making and breaking electric circuits." R. D. SMILLIE. Dated April 2.

4931. "Battery; regulating same." M. BAILEY, J. WARNER. Dated April 2. (*Complete.*)

4978. "Holder and switch for electric lamps." F. T. SCHMIDT. Dated April 4.

4980. "Making and breaking electrical circuits in connection with call or alarm boxes." F. T. SCHMIDT. Dated April 4.

5009. "Charging and re-charging, cleansing, changing, and varying the chemicals and liquids used in secondary batteries." J. T. ARMSTRONG. Dated April 4.

5025. "Electric cables; protecting same." J. H. DUNHAM. Dated April 5. (*Complete.*)

5039. "Applying electricity to treating vegetable fibres." W. B. NATION, J. J. WORSWICK. Dated April 5.

5092. "Electrical switches." B. EGGER. Dated April 5.

5096. "Dynamo-electric machinery." G. KAPP. Dated April 5.

5119. "Machinery for covering electrical wires, &c." A. JAMES. Dated April 6.

5122. "Thermo-electric elements." G. E. DORMAN. Dated April 6.

5125. "Thermo-electric elements." G. E. DORMAN. Dated April 6.

5128. "Electrical arc lamps." A. GRUNDY. Dated April 6.

5130. "Furnishing electric power at a distance." E. A. WILLIAMS. Dated April 6.

5137. "Electropathic belt." H. J. DALE. Dated April 6.

5140. "Galvanic batteries." W. H. QUARTERMAN. Dated April 6.

5186. "Brush holders for dynamo-electric machines." A. P. TROTTER, W. T. GOOLDEN. Dated April 7.

5193. "Generating and distributing electricity." G. A. GRINDLE. Dated April 7.

5199. "Distributing electrical energy for purposes of locomomotion." W. LOWRIE, C. J. HALL. Dated April 7.

5210. "Automatic apparatus for subjecting persons to the action of electric currents." A. SERRAILLIER. Dated April 7.

5228. "Sockets or holders for incandescent electric collar lamps." W. H. BAYLEY. Dated April 9.

5252. "Facilitating communication by speech between rooms, &c." H. P. F. JENSEN. Dated April 9.

5271. "Electrical type setter." J. D. DALLAS. Dated April 12.

5274. "Electric clock." R. RENDELL. (Communicated by A. B. Jones.) Dated April 12.

5289. "Electrically and mechanically sending and receiving by the same wire, indicating signals on ships, for railways, in houses, &c." P. WILLIAMS, W. POWLES. Dated April 12.

5292. "Electric motors." H. J. ALLISON. (Communicated by the Baxter Electric Manufacturing and Motor Company.) Dated April 12. (*Complete.*)

5293. "Horizontal governors especially adapted for electric motors." H. J. ALLISON. (Communicated by the Baxter Electric Manufacturing and Motor Company.) Dated April 12. (*Complete.*)

5303. "Dynamo-electric machines." H. W. RAVENSHAW, W. T. GOOLDEN, A. P. TROTTER. Dated April 12.

5309. "Laying, supporting, and repairing electric conducting wires and cables, &c." H. FLAD. Dated April 12. (*Complete.*)

5318. "Utilising electric currents in connection with relays for measuring the strength of currents." J. E. WATSON. Dated April 12. (*Complete.*)

5328. "Electric clocks." A. L. PARCELLE. Dated April 12. (*Complete.*)

5341. "Electric bells and indicators used therewith." F. L. RAWSON, C. S. SNELL. Dated April 12.

5365. "Acoustic or tone telegraphy." W. T. BARNARD. Dated April 13.

## ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1886.

13471. "Improvements in apparatus for giving off currents of electricity for curative or other purposes." A. BELLINGHAM and M. JUSTIN. Dated October 21. 8d. Relates to an apparatus for automatically giving off currents of electricity for curative or other purposes and has for its object to provide means for automatically setting in operation the various mechanisms and parts contained in the apparatus described by dropping in a coin or the like. The claims are two in number.

15271. "Improvements relating to apparatus for regulating the flow of electric currents." H. H. LAKE. (Communicated from abroad by Elihu Thomson, of America.) Dated November 23. 8d. Consists essentially of an adjustable rheostat composed of an electric conductor whose resistance is variable by changes of temperature combined with means independent of the current to be adjusted and flowing in said conductor, for varying the temperature of the same so as to vary its specific resistance with a given current. Consists further in the combination with the field magnet coils for a dynamo machine or motor of an electric conductor whose resistance is variable by changes of temperature and is properly connected to said coils so as to be effective in varying the flow of current in the same, and suitable means manually or automatically controlled, for varying the temperature of said conductor, as for instance by varying its exposure to a cooling or heating influence. Consists further in the combination with a conductor whose resistance is variable by changes of temperature, of an enclosing case formed of suitable material that is a non-conductor of heat so as to limit the loss of heat by radiation or convection, and means for varying the changes of temperature produced in said conductor by external influence. The claims are 10 in number.

15334. "Improved means for operating electrical switches and water and other taps." C. BROWETT. Dated November 24. 6d. Relates to that class of switches in which the switch bar or plate is rocked from one position to another to operate an electrical or other shunt, and has for its object to render more easy the tipping or rocking of such bar or plate, and thus to reduce the power required to be applied to the operating cord or lever. Claims:—1st. The improved means for operating electrical switches, substantially as described and shown in the drawing. 2nd. In operating electrical switches and water and other taps, the employment of a T head acting upon pins or projections upon a switch bar plate or arm, substantially as shown and described, and for the purpose set forth.

15403. "Improvements in the preparation of organic matter for metallisation by galvanic deposit." A. J. BOULT. (Communicated from abroad by La Société anonyme de Metallisation artistique des animaux, vegetaux ou autres corps, of Paris.) Dated November 25. 4d. Claims:—The method of preparing organic matter for metallisation and for receiving a galvanic deposit consisting in immersing the objects successively in the following two solutions:—1. In a solution consisting of about 100 grammes of distilled water and about 30 grammes of a solution formed by mixing the albumen obtained from snails or slugs in the above described manner with about 30 per cent. of nitrate of silver. 2. In a bath of distilled water containing about 20 per cent. of nitrate of silver in solution, the whole substantially as and for the purpose specified.

15509. "Improvements in electric lamps." M. WHEELER. Dated November 27. 6d. Consists in the combination of a suitable holding device, or cup, the two wires or wire which conduct the current, an amorphous mass or body of zirconia, in either a powdered or a solidified form, and which is placed in the cup, recess, or cavity in the holder, and in which the ends of the wires extend, the electric current being made to pass from one wire through the zirconia to the other. The object of the invention is to utilise the intense light which is produced by zirconia when heated by an electric current for illuminating purposes. The claims are 4 in number.

15523. "Improvements in electric short circuiting switches." A. BERNSTEIN. Dated November 27. 6d. In a system of electric lighting in which electric devices such as lamps are placed in series, it is necessary to provide for a switch which produces a short circuit round such lamps so as to be able to divert the current from them. If these currents are of high electromotive force it is further desirable that the devices or lamps shall be out of all metallic contact with the circuit if they are not traversed by the current. The object of the present invention is to provide a suitable simple and effective apparatus of this kind and further to combine such an apparatus with the improved automatic cut-out described in the application dated 28th September, 1886, No. 12,315. The claims are 2 in number.

15733. "Improvements in method and apparatus for producing and utilising electricity." R. A. PARRISH. Dated December 1. 8d. The inventor causes a condensation, preferably at a low temperature, of steam, which in undergoing this physical change gives up its caloric, producing an equivalent quantity of electricity which may be stored or utilised for industrial purposes in the manner specified. The claims are 12 in number.

15961. "Improvements in electric batteries." H. H. LAKE. (Communicated from abroad by the Count Rudolphe de Montgelas, of America.) Dated December 6. 6d. Claims:—1. In a galvanic cell, a positive element of aluminium. 2. In a galvanic cell, an element of zinc and an element of aluminium. 3. In a galvanic cell, a positive element of a material other than aluminium, with circuit connections of aluminium.

16352. "Improvements in telephones." W. J. MORTON. Dated December 14. 8d. Claims:—1. In an instrument for transmitting or receiving sound, speech, or signals, the combination with a coil included in an electrical circuit, of a magnetised steel-plate or magnet serving solely, in and of itself, as a diaphragm for the instrument, substantially in the manner and for the purpose herein set forth. 2. The combination in an electrical circuit of two or more telephonic instruments each consisting of a steel-plate or disc permanently magnetised to constitute independently and in itself a complete magnet, and a wire coil placed in inductive proximity thereto and included in the circuit, said permanent magnet serving as the metallic diaphragm of the instrument, substantially in manner as set forth. 3. The combination in a telephonic instrument, of a steel diaphragm constituting independently in itself a complete permanent magnet, with an annular reinforcing magnet, and a wire coil, substantially in the manner and for the purpose set forth.

16578. "Improvements in the construction of switches for the making and breaking of circuits conveying electric currents." C. M. DORMAN and R. A. SMITH. Dated December 17. 6d. Claims:—Firstly, the combination of a spring with a spindle having a cam or projections and carrying an arm or arms for the purpose of making and breaking an electric circuit, the spring being so arranged that it embraces the spindle and by pressing on the cam or projections at opposite or approximately opposite points exerts a force of the nature of a mechanical couple tending to urge the arm round in a direction varying with its position, substantially as and for the purposes described. Secondly, the improved switch as a whole, substantially as described and shown in drawings.

16917. "Improvements in grapnels for submarine cables." A. JAMIESON. Dated December 24. 6d. Has for its object to improve the construction and action of grapnels to be used for hooking and raising submarine telegraph cables, and which are of the kind described in specification No. 4,167 of 1876. The improved grapnel is made with only two comparatively strong movable flukes or prongs instead of five comparatively weak ones like the grapnel described in the said earlier specification, a special device being adopted for insuring that one of the flukes shall always be in a position for catching a cable, whilst the same device is also made to serve as a guide when the grapnel is being drawn along the bottom of the sea, and to prevent it from being held or jammed between rocky projections. The claims are 2 in number.

## CORRESPONDENCE.

### Induction Coils or Transformers.

I have been much interested in reading the historical matter connected with the distribution of alternating currents by induction coils or transformers, contributed by Mr. Rankin Kennedy, and the first part of which appears in your issue of March 18th, 1887.

I think it will be of interest to your readers and useful in the history of the subject I state the following facts:—

On November 8th, 1878, I filed in the United States Patent Office, jointly with Prof. Houston, an application for a patent for an induction coil system in which the secondary wires of the induction coils differed from those of the Ruhmkorff coils in being made of coarse wire instead of fine wire, and used to run vibrating arc lamps, which application was rejected on the ground that there was no invention in substituting coarse for fine wire in the secondary.

On January 13th, 1879, a description, which is still in my possession, was written out and dated, describing and showing by drawings the connection of the coils in multiple arc from a main line, with vibrating arc lamps operated by the secondary currents. It was recognised at the time that the working of one branch would not, with a constant potential between the mains, affect the work in the other branches. In February, 1879, having completed an alternating current dynamo, a pair of induction coils were connected in multiple from the mains running from the machine, and the arrangement tested. The coils used were such as are described in the *Franklin Institute Journal* of January, 1879, in which the two conductors were surrounded by a sheath of divided iron, and the testing was done at the Institute, the engine there furnishing the power for the dynamo. This was before the day of incandescent lamps, and as several years elapsed before such lamps could be freely purchased, there was, in 1879, no market for an induction system.

My time has been so completely occupied with various developments in the field of electric lighting

that I have hesitated to enter into any of the discussions on these matters which have appeared from time to time, and I make the above statement feeling that it is right and proper under the circumstances.

I notice also in your issue of March 18th, 1887, a paragraph accredited to *Industries*, saying that "La Société pour le Travail Electrique des Meteaux" had bought up all the patents connected with electric welding, and other applications for working metals by electricity. This is somewhat interesting to me, as I now happen to hold some patents connected with the subject.

**Elihu Thomson.**

*March 30th*, 1887.

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### Single Needle Duplexing.

The letter of Mr. Arthur E. Gilbert, in your issue of the 8th inst., calls for a reply, and I ask the favour of space therefor.

He says there has been a mistake somewhere, and I cordially agree with him; as, if what he recalls of the needle duplex working said to have been "established" by him, for his father, on the N. B. railway some 14 years ago, was a fact, then surely a "mistake" was made in abandoning it, *if it were more than a mere experiment;* but I fail to see what the admittedly bad management of a too meagre staff has to do with the electrical act of providing a properly duplexed circuit, capable of carrying the presumably extra quantity of messages necessitating duplex working. He even makes the case worse when he says, "Fortunately we had on the circuit no intermediate stations to shut out from communication, which, of course, could not but add to its efficiency"; for, if these extra aids to efficiency were on the side of the N. B. Railway superintendent's experimental circuit, is not the mistake made in abandoning such an auxiliary, all the more glaring, seeing that with the whole of the disadvantages he enumerates, there is a duplexed circuit working daily, being more than double the length of the Glasgow-Edinburgh experimental one, with over treble its resistance, and that, too, of a much more varying character than would have been the case upon the one referred to.

Further as to the attempt to minimise the value of duplex working with a view to lessen the usefulness of the single needle duplexed, I fear Mr. Gilbert tries to prove too much, for most certainly facts, and authorities, as well as common sense, are against him. The so-called difficulty of getting a doubtful word repeated, is inherent in every system of duplex, but in practice is not found to give any bother, as the asking of a question by the sending clerk should not hinder the continued receipt of messages, whereas on an ordinary single worked wire, both the forwarded and received messages are delayed by such repetitions. Let me say, also, that no less an authority than Mr. W. H. Preece, F.R.S., Electrician-in-Chief of the Postal Telegraphs, London, maintains that not only is duplex working fully equal to doubling a wire, but that the output is actually more than from two separate circuits, worked up and down, in the usual way. So much for Mr. Gilbert's views as to questionable benefits of duplexing. His next statement, however, can scarcely be looked upon as an argument, viz., that more clerks are required for the duplex than for ordinary single needle working. Surely a veritable Daniel come to judgment upon a matter so patent? He here makes the "mistake" of losing sight of the fact that a duplexed needle is practically two circuits, and in order to work these efficiently there must be the equivalent of a duplexed telegraphist at either end, which, in other words, means two extra clerks; *but the saving of the cost of* (*erecting*) 104 *miles of new wire, two single needles and six* 12*-cell Leclanché batteries, and the annual saving of the cost of maintenance*—as is the case on the Caledonian-Glasgow-Carlisle circuit—are facts which I venture to say are of advantage even to a railway company. But in actual practice—which is better evidence than the mere memory of an experiment 14 years old—there is no trouble or difficulty in working singly when occasion requires, and of immediately resorting to duplex directly a rush of work comes, and that, too, without disturbing the single working. Then as to the varying resistance of the line requiring much attention, it is a fact that no alteration of the rheostat is required until it has altered fully 200 ohms, which with sleet, snow, rain, and sunshine, on various sections of the line at the same time, requires a little while to accomplish.

Then, in "corroboration of the wisdom" of the idea that the duplexing of single needles is the "reverse of advantageous to the railway telegraph service," he triumphantly points to the Post Office as not having duplexed a single needle during all the 14 years referred to, apparently ignorant of the fact that the few single needles taken over by that department were all on local circuits, and even these were rapidly replaced by sounders, &c., so that there never were any to duplex, even if the experiment referred to had been well known. As it is, there does not appear to have been any registration of its birth, or tombstone to record its death and burial; so that it looks very much like an impossibility for any one to have disinterred so mythical a system of duplexing.

But the chief point of novelty and interest, however, Mr. Gilbert *generously* ignores, viz., the extreme simplicity of the system recorded by you on 25th March, wherein an ordinary single needle is converted into a complete duplexed instrument by its being cut in two, and the single-wound coils utilised in the manner described. This is an entirely new departure, and one which, I venture to say, will be largely taken advantage of by other telegraph superintendents; and the readers of your valued journal will judge who has made a "sorry mistake."

**Andrew S. Dunn.**

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### Chatterton's Compound.

I am obliged to Mr. Willoughby Smith for furnishing, in your last issue, the correct particulars of the patent for the so-called "Chatterton's Compound."

I knew that the ultimate success of this adhesive mixture, as we now have it, was mainly due to Mr. Smith, but supposed it to have been originally the result of the joint efforts of Mr. John Chatterton and Mr. Willoughby Smith, believing it to have been patented in 1859, at a time when so many joint patents were taken out by them; remembering at the same time that Mr. Chatterton had exercised his mind considerably in the application of gutta-percha round wires.

I was unable to find the patent specification readily, so assumed it to come under one of their joint patents of that year.

I have since read, with much interest, the patent as given by Mr. Smith (No. 1,811, 1858), and shall remember in future that which many, I believe, are not aware of, that this successful adhesive mixture, commonly known as Chatterton's compound, was really patented and introduced by Mr. Willoughby Smith.

I am glad that my remarks have elicited this fact, which might never, otherwise, have become generally known.

**Charles Bright, Jun.**

*March 12th*, 1887.

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### Sparking in Telegraph Relays.

I might perhaps have been better able to reply to Mr. Fisher's remarks had he stated the apparatus with which his batteries are used.

My article referred only to rapid telegraph translators, and none of the phenomena mentioned would be noticeable in other, nor indeed in similar apparatus, unless it was used under similar conditions.

A relay used upon a circuit worked by hand and having a large play (say $\frac{1}{100}$th inch) might work for

several months without readjustment. And keys are used for years without requiring attention. But upon circuits worked automatically, where from 250 to 500 words a minute are transmitted, the currents are sent at the rate of 200 to 400 to the second, and the force by which the tongue is actuated is very weak: consequently, it is necessary to make the play as small as possible; and to obtain these small plays the sparks have had to be suppressed by the methods I have described. It is possible that Mr. Fisher's apparatus is not worked with a small play, and he would not, therefore, notice the sparks, nor would there be any need to suppress them. And if the play of his apparatus is too large for the battery to become accidentally short-circuited, it is quite unnecessary to correct the battery resistance.

There is a general misconception as to the length of the play used upon telegraph relays. "Culley" says the play of a Siemens relay should be $\frac{1}{25}$th inch. "Preece and Sivewright" say $\frac{1}{32}$nd inch. Both of these plays are much too large; it is doubtful whether a play of $\frac{1}{100}$th inch was ever used upon a polarised relay. At present the play of a relay working a local circuit is generally less than $\frac{1}{300}$th inch, while the play upon an automatically worked circuit is sometimes less than $\frac{1}{3000}$th inch.

The play of the tongue may be readily measured by counting the number of threads to the inch upon the contact screw and then measuring the angle through which the screw requires to be turned to close the play. For instance, if the contact screw has 50 threads to the inch and the play is closed by turning the screw through 45°, then the play would be $\frac{1}{400}$th inch.

**W. Moon.**

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### The Incandescent Lamp War.

I feel sure many of your readers as well as myself must have read with considerable interest Mr. Radcliffe Ward's letter which appeared in your last issue relative to the above subject; and, if all that Mr. Ward states can be proved to be facts (which I do not doubt) respecting Mr. Lane-Fox's incandescent lamp patents, what can we electricians have to fear that a monopoly of the entire lamp trade can be sustained by any one company? To my mind, Mr. Lane-Fox was in his researches far ahead of Mr. Edison in the year 1878, and his specification contains all the essential points for a successful and good *high resistance* lamp, which was considered to be the missing link in the chain required to make electric lighting a success.

Undoubtedly the thanks of the nation are due to both Lane-Fox and Edison for improvements made on the *earlier* types of *low resistance* lamps then known to electrical science. The question to decide resolves itself into which of the two inventors had produced the best lamp in 1878. This could easily be decided by actual tests made by unbiassed experts.

It is but natural that the partisans of both these gentlemen will do their best to secure the laurels for their respective parties in the legal war about to be commenced by the owners of the Lane-Fox and Edison patents; but who will be victorious yet remains to be seen, since this question will be fought out on widely different lines from those adopted in the late Woodhouse and Rawson trial, there being, as is now well known, many points relating to the subject which will tend to alter the present position and aspect of affairs when brought forward in the forthcoming trials, several of which are now pending. It must not be forgotten that Lane-Fox and Edison, and also Mr. Swan, were all experimenting with a view to the special requirements of the Gramme machine of that day; but as time went on other improvements in electrical machinery were invented. Improved batteries, both primary and secondary, began to make their appearance, which set a host of inventors thinking how to invent a practical *low resistance* lamp (as opposed to the *high resistance* lamp so distinctly claimed by Mr. Edison, which was unsuited for battery lighting), for small installations and for primary battery work. The modern low resistance lamp is of equal importance with the high resistance, and each of these is suited to its own special work, and unsuited to work out of its own sphere, so that they are not interchangeable, and, therefore, are radically different. Amongst these low resistance lamps may be cited those of Zanni, Bernstein, Shippey, Gerard, and Cruto, which are about the best known inventions in the latter class of lamp, and all of which have done good work in the development of the electrical industry, having paved the way for electric lighting installations which have developed out of the use of a few small lamps lighted by a Grove or Bunsen battery, which small installation work would never have been carried out if fifty or sixty cells were needed to produce a light in a lamp of high resistance. I therefore, as an electrician, am quite in favour of encouraging this small work, which serves to pioneer work of greater importance. One can well understand that the lamp business is a very profitable one at the present prices charged, and it is now well known that there are not more than, say, four or five valid patents which can hold their own; and the question is, would it not be better for the few firms now left to come to a proper understanding, and thus end their squabbles. Let them agree to a fixed price to be charged by the trade generally, and leave the public to decide which lamp it prefers to use. If this course were adopted confidence would be gained, and orders for plant increased tenfold, and money subscribed to carry on and extend the grand work already begun. Now that we have a workable act in store, the business must increase, and millions of lamps will be required of both high and low resistance, so that there will be ample room for all, now that we have the necessary improved dynamos, accumulators, and primary batteries ready to run them. My advice is to shake hands all round, get to work, and that, too, before the expiration of the patent rights, as by so doing we shall prove ourselves wiser men, become richer, and, in addition to this, find employment for hundreds of poor electricians and others who have at present no work to do, owing to the war now pending, to the detriment of the many and the profit of a few.

If you can find space in your next issue for this letter will you kindly insert it, and oblige one of the early workers in the development of a science which well merits the support of the British nation, and which must extend as soon as the battle of incandescent lamps is over?

**Electrician.**

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### Local Action in Batteries.

In your issue of March 25th, there is an article on "Local Action" in batteries, by Mr. W. Moon. It would be interesting to hear whether this kind of action, on a more extended scale, does not take place in the Upward battery, more especially in the "New Type."

Supposing that one of the porous pots had a less resistance than the others, a larger current would pass through that cell, with the result that the chloride of zinc would be of greater density there than in the others: this would set up an E.M.F. between the zincs. From experiment this E.M.F. was found to be about ·05 volts with two zinc plates in chloride of zinc of the following sp. g., 1·09 and 1·32. This difference might also be brought about by the liquid passing more freely through some of the porous cells than others, water being added to fill up.

From my own experiment I have found, if a cell is left in action for a week or more, that there may be a difference of ·3 in the sp. g. (1·3 to 1·6) of the chloride of zinc in the same porous cell: with the result that before the plate is properly used up it will break in two, just about where it leaves the liquid.

I may mention that I hope shortly to bring out an improvement which overcomes this difficulty, and which also has some other advantages.

**J. E. Pearce.**

*March 6th*, 1887.